P
Univ
G

Bulletin of the University of Georgia

VOLUME XXXI MARCH, 1931 NUMBER 3a

PHELPS-STOKES
FELLOWSHIP STUDIES
NUMBER 10

THE WATER SUPPLY OF THE NEGRO

By Ernest B. Wilson, M. S.
Phelps-Stokes Fellow in the University of Georgia, 1926-27

LIBRARY
APR 21 1932
UNIVERSITY OF TORONTO

PRICE 80c.

Entered at the Post Office at Athens, Ga., as Second Class Matter, August 31, 1905, under Act of Congress of July 16, 1904. Issued Monthly by the University.

SERIAL NUMBER 493

UNIVERSITY OF GEORGIA PUBLICATIONS

The University of Georgia publishes the special series listed below:

ADDRESSES.

Chiefly delivered on the occasion of anniversary, commencement. or other special convocations.

BUREAU OF BUSINESS RESEARCH STUDIES.

Published on a fund provided by friends of the University.

INSTITUTE OF PUBLIC AFFAIRS ADDRESSES.

Delivered at sessions held annually during the Summer School, and dealing with state, national, and international problems and affairs.

PHELPS-STOKES FELLOWSHIP STUDIES.

The published results of work done toward a "scientific study of the negro and his adjustment to American civilization" by holders of the Fellowship established in 1912 by Miss Caroline Phelps-Stokes.

List of those thus far published will be found on the inside back cover.

STUDIES.

Original work by members of the University Faculty, thus far largely in the field of Southern history.

DISTRIBUTION

Requests for any of the above publications from citizens of Georgia, and communications from libraries concerning exchanges, should be addressed:

Chairman, Publications Committee, General Library, University of Georgia, Athens, Georgia.

Single numbers of any of the above series will be sent on application, so long as available, to citizens of Georgia.

The following journal is published jointly by the Bureau of Business Research and the Citizens and Southern National Bank.
GEORGIA BUSINESS REVIEW.

Requests for this publication should be addressed to the Bureau of Business Research, School of Commerce, University of Georgia, Athens, Georgia.

THE WATER SUPPLY OF THE NEGRO

A Study of the Sanitary Conditions of the Water Supply of Negroes in Urban and Rural Communities with Sociological Interpretations

By Ernest B. Wilson, M. S.
Phelps-Stokes Fellow in the University of Georgia, 1926-27

A thesis presented to the Faculty of the
University of Georgia in partial fulfillment
of the requirements for the degree of
Master of Science

TABLE OF CONTENTS

Page

CHANCELLOR'S FOREWORD ---------- 3

PREFACE ---------- 4

INTRODUCTION ---------- 5

CHAPTER I. THE SANITARY ANALYSIS OF WATER SUPPLIES ---------- 10

The Sanitary Survey, 10-11; The History of the Water, 11-12; Taking the Specimen, 12; Chemical Examination, 12-13; Free Ammonia, 14-15; Albuminoid Ammonia, 15; Nitrites, 16; Nitrates, 16-17; Chlorine, 17-18; Oxygen Required, 18; Total Solids, 18-19; Loss on Ignition, 19; Hardness, 19-20; Turbidity, 20; Dissolved Oxygen, 20-21; Reaction, 21; Conductivity, 21; Methods Used in Chemical Examination, 21; The Bacteriological Examination, 22-24; The Physical Examination, 24-25; The Microscopical Examination, 25-26.

CHAPTER II. THE TERRITORY STUDIED AND TABLES OF DATA ---------- 27

Some Water Supplies of Known Purity, 28-33; The Community of West Athens, 33-44; The East Athens Community, 44-46; The Winterville Community, 46-47; The Rural Community Between East Athens and Winterville, 49-52; The Watkinsville Community, 52-54; Augusta Community, 54-57; The Dudley Community, 57-61; The Rural Community Near Dudley, 61-63; Wells of Special Interest, 63-66; Summary of Data, 66-68.

CHAPTER III. SOCIOLOGICAL IMPLICATIONS ---------- 69

Meeting the Problem of Water Pollution, 70-79.

REFERENCES ---------- 80

CHANCELLOR'S FOREWORD

Upon the recommendation of the Phelps-Stokes Committee of the University of Georgia Mr. E. B. Wilson was appointed as Phelps-Stokes Fellow for the year 1926-27. The thesis represents a study made by the cooperation of the Department of Agricultural Chemistry and the Department of Sociology. The data were gathered under the direction of Professor L. M. Carter of the former Department, and the Sociological Interpretations were made under the direction of Professor G. A. Hutchinson of the latter Department.

The Phelps-Stokes Fellowship was established for the purpose stated in the following resolutions:

"Whereas, Miss Caroline Phelps Stokes in establishing the Phelps-Stokes Fund was especially solicitous to assist in improving the condition of the negro, and

"Whereas, It is the conviction of the Trustees that one of the best methods of forwarding this purpose is to provide means to enable southern youth of broad sympathies to make a scientific study of the negro and of his adjustment to American civilization,

"Resolved, That twelve thousand five hundred dollars ($12,500) be given to the University of Georgia for the permanent endowment of a research fellowship, on the following conditions:

"1. The University shall appoint annually a Fellow in Sociology, for the study of the Negro. He shall pursue advanced studies under the direction of the departments of Sociology, Economics, Education or History, as may be determined in each case by the Chancellor. The Fellowship shall yield $500, and shall, after four years, be restricted to graduate students.

"2. Each Fellow shall prepare a paper or thesis embodying the result of his investigations which shall be published by the University with assistance from the income of the fund, any surplus remaining being applicable to other objects incident to the main purpose of the Fellowship. A copy of these resolutions shall be incorporated in every publication issued under this foundation.

"3. The right to make all necessary regulations, not inconsistent with the spirit and letter of these resolutions, is given to the Chancellor and Faculty, but no changes in the conditions of the foundation can be made without the mutual consent both of the Trustees of the University and of the Phelps-Stokes Fund."

CHAS. M. SNELLING,
Chancellor.

NOTE:—In justice to Mr. Wilson it should be said that this thesis was accepted in June, 1927, and its late publication is in no way the fault of Mr. Wilson.

PREFACE

Since the initial publication of Phelps-Stokes Fellowship studies at the University of Georgia n 1914, several bulletins dealing with various phases of negro life such as his homes, his churches, his lodges, his educational progress and facilities, and his industrial and economic level have appeared. In connection with these previous studies it seemed worth while to secure more information in regard to the health conditions of negro life. With this as an objective I have attempted in this study to gather facts about the purity of shallow well water supplies being used by negroes for drinking and general domestic purposes.

In order that as much territory as possible might be covered in the time available for the work some tests of value indirectly or in special cases were omitted in the sanitary analyses of the pecimens. However, no tests which would have been inconsistent with a high standard of accuracy were omitted.

As an aid to those who may not be familiar with the procedure and interpretation of sanitary water analysis, a brief explanation of each test made and its significance has been included.

The data include the sanitary analyses of eighty-one specimens of water supplies. Seventy-four specimens were from shallow well supplies which were being used by one hundred and thirty-one negro families.

The work on this study began in August of 1926, immediately after the close of Summer School and was carried on continuously until the close of the spring term of 1927. In addition to the time spent in reading, two months were spent in the laboratory preparing solutions and making the examinations. Another month was spent in making sanitary surveys, getting specimens, and taking photographs. Much time was required for making calculations and tabulating data.

It is with many thanks that I wish to acknowledge the interest and help of many others in the preparation of this thesis. I especially wish to thank Dr. A. S. Edwards for suggesting this subject, Professor L. M. Carter who directed my sanitary surveys and chemical examinations, Dr. W. C. Burkhart who directed my bacteriological examination, and Dr. Geo. A. Hutchinson who guided me in sociological study of the data obtained and in the preparation of this thesis.

E. B. Wilson.

Athens, Georgia,
June 10, 1927.

INTRODUCTION

Water, as it occurs in nature, has little significance in a study of health conditions. Its purity depends on such factors as the kind of soil through which it passes, the density of population, the height of the water level, and the climatic condition. It is by the steps which an individual takes to purify his water supply or to protect it from contamination that we get an insight into the health conditions of his life. This statement might be applied to a community. In fact, we are able approximately to trace the health progress of a community by the provisions taken to secure a pure supply of water. For, where there is progress in health conditions, we find wells which are properly constructed in suitable locations and with efficient means of preventing surface contamination. Such wells generally furnish pure water.

The importance of pure water in relation to health may be seen from a consideration of the part which water plays in the functioning of the body. Water gives no energy to the body, but about two-thirds by weight of the human body is water. It carries food from the digestive tract and oxygen from the resporatory organs to the millions of cells of which the various organs are built. In the same manner, it carries the waste products of the cells to the organs of elimination. The turgidity of the cells is due to their distention by water. The temperature of the body is regulated largely by evaporation of water. The proper condition of the blood is maintained principally by water. The work of other organs depend more or less on water also.

While some of the water used in metabolism is deriver from corbohydrates and other food materials, most of it is taken into the body by drinking. The average consumption of water in this way varies considerably with individuals, occupations, and the seasons of the year. It is seldom less than a quart and often runs as high as a gallon per day. No other utility is so often used in such quantities. If the water is pure, no other utility does so much to promote the health of man.

Since it is used constantly, water may be the channel through which much sickness, many permanent disabilities, and some deaths are brought to a community. Diseases of intestinal nature are usually water borne. Chief among these and the one most dreaded in our country is typhoid fever. There is no doubt in the minds of physicians today that this disease is spread by water. In laboratory tests where typhoid germs are put in ordinary drinking water, most of them die within a week. But generally, a few are found alive several months in water otherwise suitable for drinking. Tests are reported where they have been found alive after long periods in solid ice. Typhoid is very insidious. One seldom recovers completely from its ravages. After being pronounced cured by the physicians, one generally finds that the fever has permanently impaired some important organ of the body, as the kidneys.

A few illustrations[1] will show how serious is the danger of taking typhoid fever from germs in polluted water. In 1914, ninety cases of typhoid and seven deaths in California were caused by a water supply contaminated by a septic-tank discharge which drained a long distance above ground and then one hundred and forty-one feet through gravel. In 1915, a heavy rain gorged a house sewer in Virginia whence some water escaped to the pit at the top of a drilled well and followed down the casing. Within fourteen days five of the eight children in the family were stricken with typhoid fever and the eldest died. Many simillar cases could be cited.

An illustration[2] just as potent is furnished by the section of Athens east of the Oconee River. For several years before city water mains were extended to this section there were annual epidemics of typhoid fever in the summer. Since the city mains have been extended to most of this section, these epidemics have practically ceased.

Another disease very much dreaded in Europe and Asia because of its fatal effects is cholera. America has not experienced many outbreaks of this disease. Those which have occurred were promptly checked. There exists positive proof of this disease being spread by water used for drinking. The germs can be isolated from water comparatively easily. This disease usually disappears from a locality when the water supplies are properly looked after. In addition to checking its spread the sanitary measures employed automatically eliminate breeding grounds of the germs.

---

[1] Farmers' Bulletin 1448, 3, U. S. Department of Agriculture.

[2] From the notes of Dr. W. C. Burkhart, Professor of Bacteriology, Georgia State College of Agriculture.

Dysentery often sweeps entire sections of our country districts. Epidemics of this disease come most frequently in the spring. This is the time when the labor of farm hands is in great demand. While in general it is a comparatively mild disease, any derangement of the organs of elimination of body wastes is sure to lower the tone of one's system and thereby the efficiency of agricultural labor is greatly impaired during one of the busiest seasons. Moreover, in some of its forms, such as diarroeheas among children it may prove fatal. In all instances the water supply should be suspected, as dysentery is a water borne disease.

Some authorities think that tuberculosis may be spread by drinking water where circumstances favor it. Fortunately, such occurrences are not very numerous. These germs do not live very long in ordinary drinking water and can be transmitted only when someone drinks water which has been infected very recently.

One of the most unhealthy conditions, particularly in the South, is the prevalence of intestinal worms. A large number of the worms are probably taken into the intestinal tract by drinking impure water which contains them. Among the worms found in impure water are hookworms, roundworms, whipworms, eelworms, tapeworms, and seatworms. The importance of guarding against worms has been demonstrated by several campaigns of the United States Bureau of Health. Some of these campaigns were waged especially against hookworms in the South. A pure water supply would do much to remove this poor health condition.

In addition to the germ diseases and prevalence of worms mentioned above, contaminated water may contain harmful chemical substances such as by-products of putrefaction. Some of these products such as the amines are poisonous to the human systems. Also, in localities where arsenic, lead, copper, and a few other similar metals may occur in the water, the mineral content may be detrimental to health.

Besides the facts pointed out above, pure water appears to have other beneficial effects on health that cannot be directly accounted for. About forty years ago when purification of city water supplies began to be general, it was noticed in America and in Germany[3] that the purification of a water supply of a city caused an improvement in the health of the city from one and one-half to sixteen times as great a ratio as possibly could be attributed to the decrease in typhoid fever and cholera which it was known that water purification would reduce. This phenomenon has been found to hold for most of several cities studied, although no satisfactory explanation has been offered. It may be due to the fact that purified water is usually more palatable and that people drink more of it. Drinking plenty of pure water is an excellent thing for health at any time since water is used in many ways by the body.

Relatively, the United States has had a very small number of disastrous epidemics of diseases. One of the things that helped to keep down the epidemics here was that we were not as crowded as the nations of Europe and Asia. This is not as true today as it was a few years ago and we may expect our country to become as densely populated in the future as any other modern nation. While the sparsity of population and other factors favorable to us have operated in the past, we cannot hope to enjoy any advantages in the future other than those gained from constant vigilance on the part of our health and educational boards.

Impure water supplies where shallow wells are used as a source is one of the most important problems that must be met by those who seek to improve health conditions. The magnitude of the problem of polluted water supplies where shallow wells are used is indicated by the work of the Department of Agriculture. For the past twenty years various Bureaus of the Department have been studying the purity of rural water supplies. These surveys[4] indicate that three out of every four farm water supplies are sufficiently polluted to be unsafe. An investigation of rural water supplies in Minnesota[5] revealed that only twenty out of a total of seventy-nine typical rural wells were pure. A Canadian investigator[6] who has studied the rural water supplies of Canada since 1887 states that only thirty per cent of the supplies which he had investigated could be classed as safe.

---

[3] Mills-Reincke Phenomenon.

[4] Farmers' Bulletin No. 1448, 3, U. S. Department of Agriculture.

[5] Bulletin 154, 83, Bureau of Plant Industry, U. S. Department of Agriculture.

These facts and the poor sanitary conditions around negro wells led us to question whether the negro was using pronouncedly impure water for drinking and domestic purposes. Considering the importance of the water supply in relation to health conditions as outlined above, it was thought worth while to investigate the purity of the negro's water supply. The practical way to do this was to make sanitary analyses of a number of negro water supplies. It was with these things in mind that this thesis was conceived, planned, and executed.

---

[6] Bulletin 57, 2, U. S. Department of Agriculture.

CHAPTER I

THE SANITARY ANALYSES OF WATER SUPPLIES.

Sanitary analyses of waters are made to determine whether the waters are safe for drinking purposes. Under the general heading, sanitary analysis, are included a sanitary survey, a chemical examination, a bacteriological examination, a physical examination, and a microscopical examination. After giving careful consideration to all of these phases of a sanitary analysis, a sanitary water analyst has an adequate basis for a scientific opinion as to the potability of a given water supply. In this chapter a brief discussion of the importance and procedure of each phase is given.

THE SANITARY SURVEY.

The sanitary survey is an inspection of the source and its surroundings from which drinking water is being used. In the survey of shallow wells the influence of such factors as the location of outhouses in relation to the well; drainage, both surface and subterranean; the depth below the surface of the water level; the depth of the water in the well; the type of topsoil; the type of subsoil; the method of getting water to the surface; the kind of rock and the manner in which the various strata strike into the well; the location of trees, wash benches, chicken coops, etc., in relation to the water supply; the efficiency of the cover if one is used; the efficiency of any methods of preventing surface water from running into the well; and any other factor that might make for a sanitary water supply. All these things must be considered in detail by the sanitary surveyor. The danger of contaminating matter reaching the well from the premises of neighbors must be considered also.

Some authorities consider the sanitary survey the most important part of a sanitary investigation. An expert sanitary surveyor can usually tell if a water supply is receiving contaminating matter before the chemical and bacteriological examinations are made. For the sanitary survey to be of the greatest value it should be made by an expert who has had social training in addition to his experience in making sanitary analyses of water, because he will be interested in trying to remove the cause of poor sanitary conditions as well as to discover their existence.

THE HISTORY OF THE WATER.

The history of a specimen is usually secured while making the sanitary survey It has some importance in connection with the bacteriological examination as the bacteriological standards vary somewhat with the kind of water under examination. However, it is essential to the chemical examination. Some people seem to think that a chemist should be able to tell from the results of his analysis whether the water is suitable for drinking regardless of where it came from or how long it had been taken before he analyzed it. The chemist can tell very easily whether the specimen he analyzes is fit to drink when he measures the results obtained against standards that he is acquainted with, but he must know what the normal standards are for the locality from which the specimen was secured and whether or not it is a representative specimen of the supply in order to judge the purity of the supply. A few examples will illustrate this point:

One of the specimens examined in this study had excessive amounts of chlorine. On making inquiries it was discovered that some salt (sodium chloride) had been added to kill ''wiggle tails'' a few days previous to the taking of the specimen.

Mason[7] mentions a well that had been dynamited by forty pounds of nitroglycerine as giving high results for nitrates although it was known to be pure.

Water from streams would naturally be high in organic matter. Specimens from near the sea coast or salt lakes are high in chlorine. River water that has been filtered free of all harmful organism will often show large amounts of nitrates. If chlorine has been added to kill bacteria, it should be known by the analyst. It is readily seen therefore, how important the history of a water is to the analyst making a chemical examination of it.

It is very important to the microscopical examination also as spring and surface waters will usually contain more debris and organisms other than bacteria than will well waters. The presence of such material would be misleading to the microscopical examiner if he did not know that the water was secured from a surface source.

---

[7] W. P. Mason, Examination of Water, p. 49.

Most of us are acquainted with the hydrogen sulphide odor of water containing traces of mineral sulfur. Water contaminated by fresh sewerage has much the same odor. Such odors would be confusing to the physical examiner if he did not know the history of the water under examination.

It is obvious for the above reasons that an analyst must have some knowledge of the history of the water if he is to be able to give an opinion that will be of the greatest value.

Taking the Specimen.

The specimens analyzed in gathering data for this paper were taken by the analyst. Every effort was made to take a specimen that would be representative of the water supply. No precautions were omitted to keep it from contamination after it was taken. Most of the work was done in the fall and winter months when the weather was cool enough to preserve the water in an unheated room. If the weather was too warm the specimens were kept in a refrigerator. At first glass stoppers were used in the bottles but they were so easily broken that only standard liter bottles were used for the latter specimens. New corks were used in these bottles. Two bottles were filled directly from the bucket after the bottles were washed by filling and emptying twice. The oxygen required to oxidize the active organic matter, ammonia, and nitrates were determined as soon as possible after the specimens were brought in.

The Chemical Examination.

As has already been indicated, water may contain minerals that are poisonous or otherwise detrimental to health but in the localities in which this study was made there were no such health destroying minerals. Consequently, in these studies the chemical examination is made as a search for the products of bacterial metabolism. Tests were made for the four forms of nitrogen; namely, free ammonia, albuminoid ammonia, nitrites, and nitrates. In addition to the tests for nitrogen, the amount of chlorine, the amount of oxygen required to oxidize the active organic matter present, the total solids, the loss on ignition of the solids, hardness, turbidity, the amount of dissolved oxygen, the reaction, and conductivity are determined. Each of these tests will be discussed in detail later.

Nearly all waters will give positive results for most of the tests used in the chemical examination. This is due to the natural occurence in the waters of the substances tested for. Consequently, in forming an opinion as to the potability of a speciment of water the analyst must compare the results of the tests which he makes with the results that would normally be expected of pure waters from the locality from which the specimen was taken. A small amount above the normal is permitted in each test. This maximum allowable amount above the normal is the standard for the test.

Standards vary considerably with local conditions. We were unable to find in the literature available very suitable standards for the waters from the localities in which we studied. Under the discussion of each test we have given the standard which appears to be most satisfactory.

The chemical examination is very important in analyzing shallow well water supplies because it tells something about the nature of the contamination taking place as well as establishing the fact of contamination. For instance, large amounts of nitrogen in the form of free ammonia indicate that active contamination is taking place, albuminoid ammonia indicates very recent contamination, nitrites indicate contamination which took place a little farther back than that indicated by the albuminoid ammonia, and nitrates indicate contamination which took place in the past. Continuous contamination gives positive tests for all the forms of nitrogen. If a large amount of chlorine above the normal amount to be expected in the locality is found accompanied by large amounts of the various forms of nitrogen, it indicates contamination from animal excreta which are generally high in nitrogen and chlorine compounds.

FREE AMMONIA

According to the generally recognized nitrogen cycle, plants use nitrates in building cell tissue, and animals utilize plant nitrogen in building tissue. This nitrogen in the cell tissues of plants and animals is called albuminoid ammonia. Upon decay of animal excrements as well as the decay of plant and animal tissue, free ammonia is formed by ammonifying organisms. The free ammonia is oxidized to nitrites. The nitrites are further oxidized to nitrates. According to this, free ammonia would indicate recent contamination in which ammonifying organisms were at work. These organisms produce free ammonia gradually. This permits much of the ammonia to be oxidized to nitrites and nitrates before the ammonifying process is completed. Ordinarily very large amounts of free ammonia will not be present from the action of the ammonifying organisms alone. Excessive amounts of free ammonia are due usually to contamination from animal excreta containing ammonium salts and urea. Both ammonium salts and urea break down into ammonia during the test for free ammonia. They are so easily converted into free ammonia that they do not remain in the water supply very long. Therefore, a very large amount of free ammonia indicates that active or direct contamination of animal excreta is reaching the water supply. However, free ammonia sometimes occurs in deep wells where active contamination is improbable. Its presence is explained on the theory that nitrates in the water from remote contamination which took place while the water was on the surface of the ground were reduced to ammonia.

The ammonia in itself is not detrimental to health, but indicates the presence of contaminating matter which probably contains harmful organisms which got into the water with this matter. Of course free ammonia in deep wells does not indicate the presence of contamination because it is due to the reduction of nitrates as explained above.

Ammonia is determined by concentrating by distillation 500 mls. of the specimen to 250 mls. and nesslerizing a 50 ml. tube of the distillate and comparing the color produced with the color produced in other tubes containing known amounts of ammonia as ammonium chloride.

Leeds's[8] standard for American rivers is 0.12 parts per million.

Rosenau's[9] standard for water supplies is 0.15 to 0.55 parts per million.

ALBUMINOID AMMONIA.

All the organic nitrogen compounds which have not been acted on by ammonifying organisms are designated as albuminoid ammonia. It is considered a practical index of the amount of active organic matter present. Its presence alone indicates recent contamination in which the fermentative and putrifactive agencies have not completely broken down into ammonia the complex organic compounds containing nitrogen. Its presence together with free ammonia and nitrites indicates that the contaminating matter is in a semi-putrid state.

Because the semi-putrid contaminating matter usually contains millions of bacteria, water containing much albuminoid ammonia is looked upon with great suspicion by water analysts. The analyst's distrust is greatly increased if a large amount of chlorine is present because both albuminoid ammonia and chlorine occur in large amounts if the contamination is from animal sources. Since the number of harmful bacteria is generally greater in animal contamination, the sanitary significance of albuminoid ammonia from vegetable sources is not as important as that derived from animal sources.

Albuminoid ammonia is always determined in conjunction with the determination of free ammonia. It is usually a continuation of the process for the determination of free ammonia. After 250 mls of the 500 mls. taken from the original specimen is distilled off, the remaining 250 mls. are made alkaline with basic potassium permanganate and distilled. From this point the procedure is the same as in the determination of free ammonia.

Leeds's standard for American rivers is 0.28 parts per million.

---

[8] A. R. Leeds, Water Department, Wilmington, 1883.

[9] M. J. Rosenau, Preventive Medicine and Hygiene, 841, D. Appleton & Company, New York and London.

NITRITES.

Certain organisms are able to oxidize free ammonia to nitrites. This is an intermediate step in the complete oxidation of free ammonia to nitrates. The presence of nitrites is usually due to active putrifaction of animal or vegetable organic nitrogen compounds by nitrifying organisms. This fact makes the detection of nitrites very important in a sanitary analysis of water. The presence of even small amounts in drinking water is considered very unfavorable because nitrites are so easily oxidized to nitrates that large amounts of nitrites will be found only when large quantities of ammonia have recently been acted upon.

The presence of nitrites in deep wells where contamination is improbable is explained in a manner analogous to the explanation offered for the presence of free ammonia in deep wells.

The determination of nitrites is accomplished by pouring 100 mls. of the specimen into a Nessler tube, making acid with a drop of hydrochloric acid, and adding 1 ml. of naphthylamine hydrochloride and 1 ml. of sulphuric acid. It is stirred and allowed to stand for thirty minutes. A red coloration (azobenzol- naphthylamine-sulphuric acid) forms if nitrites are present. The color in this tube is compared with the color developed in other tubes containing different known amounts of nitrites. This is a very sensitive test, being capable of indicating the presence of one part of nitrite nitrogen in one billion parts of water.

Leeds's standard for American rivers is 0.003 parts per million. Mason states that 0.002 parts per million is a safer standard.

NITRATES.

Except for small amounts absorbed by the water as it percolates through the soil, nitrates occur in well water as the final product of nitrifying organisms acting on free ammonia and nitrites which were produced from organic nitrogenous contamination. They indicate contamination of the water at some previous date. That a water supply gives positive tests for only nitrate nitrogen should not be taken to mean that it is safe to drink Although the contamination may have been remote and the albumen converted into nitrates, carbon dioxide, etc., by the putrifactive and fermentative organisms, disease germs which possibly came into the well along with the contamination may still be present. Organic contamination of vegetable nature contains relatively little nitrogen; therefore, nitrates high above the normal for the locality indicates excreta contamniation of human or animal origin.

The determination of nitrates is carried out by making 100 mls. of the specimen alkaline with sodium carbonate, evaporating to dryness and taking up with two mls. of phenol di-sulfonic acid. About five mls. of ammonium hydroxide is added after the acid has been diluted with distilled water. This mixture is transferred to a 50 ml. Nessler tube and made up to the mark. A yellow color due to the formation of ammonium picrate will develop if nitrates are present. The depth of color will depend on the amount of nitrate nitrogen present. These tubes are compared in color with previously prepared tubes containing known amounts of nitrate nitrogen.

Leeds's standard for American rivers is 1.11 to 3.89 parts per million.

CHLORINE.

The occurence of small amounts of chlorine is nearly universal. Practically all waters contain it. Water dissolves it out of the soil and air. For each locality there is a normal chlorine content depending on the presence of salt beds, the proximity of the sea, or other natural factors. It occurs usually in waters as sodium cloride, or common salt. Since salt is used in large quantities in the food of humans and animals and most of it is excreted unchanged by metabolism, an abnormal amount of chlorine in a well water supply strongly indicates contamination by animal excreta. Due to this fact the chlorine content is considered one of the most important tests in determining the purity of a water supply.

Chlorine determinations of water are very simple. In measured quantities of the water chlorine is determined volumetrically by using a standard solution of silver nitrate in the presence of patassium chromate as an indicator. The rapidity of this important test should make it valuable in checking the purity of water supplies in instances where an epidemic of a contagious disease is being spread apparently by impure water.

Mason gives the following standards in parts per million:

Ordinary sewage, about 110 to 160.

Human urine (average of 24 samples), 5872.

Leeds's standard for American rivers, 3 to 10.

OXYGEN REQUIRED.

The amount of active or carbonaceous organic matter present may be estimated roughly by the amount of oxygen required to oxidize it. It is of value only when it is considered in conjunction with other determinations. Water secured from a peaty surface stream might be excessively high in oxygen requirement and yet be sanitary from a health standpoint. Carbon from a peaty source has little sanitary significance. If the albuminoid ammonia content is high also, contamination of a vegetable nature is still suspected. But if the albuminoid ammonia content is high and the oxygen requirement low, contamination of animal nature is suspected. Greater weight is attached to the high albuminoid ammonia and low oxygen requirement if the chlorine content is high also.

The oxygen required is determined by oxidizing the organic matter in the water with dilute potassium permanganate of known strength. The permanganate is allowed to act on 200 mls. of the specimen a definite length of time. A correction is made for oxidizable minerals like ferrous compounds.

Leeds's standard for American rivers is 7 parts per million.

The French standard is 4 parts per million.

TOTAL SOLIDS.

When a hundred milliliters of the specimen is evaporated to dryness a residue is left. This residue is called the "total solids." This solid residue was disolved or suspended in the water as it came in contact with matter which was soluble or so finely divided that it was capable of remaining in suspension. It is not considered of very great value in the sanitary analysis of water. This solid residue is used in making a mineral analysis of water.

There seem to be no satisfactory standards for amount of total solids. Many standards varying from 150 parts to 586 parts per million have been suggested, but some of the Western waters of known purity have a residue of 1,200 parts per million.

LOSS ON IGNITION.

After weighing on the chemical balance, the total solids are ignited to a dull redness over a low flame. The odor and appearance of the residue are carefully noted. After a minute or two of ignition, it is cooled in a desiccator and reweighed. The loss in weight is the "loss on ignition." This loss roughly represents carbonaceous material which is easily oxidized to carbon dioxide and water and driven off. Loss of weight may result from the volatilization of a few mineral chlorides or from driving off water held by mineral hydrates.

The odor and appearance of the residue on heating is considered important because it gives an indication of the nature of the organic matter present. The specimens of dangerous waters usually give characteristic odors which the experienced analyst will soon learn to recognize. Specimens of water that contain large amounts of organic matter like peaty carbon which may not indicate anything harmful do not give very pronounced odors when their residues are ignited. Organic matter from sewage and other harmful contaminations will give a black coloration which usually is driven off by the heat. Peaty waters give a persistent coloration which is difficult to drive off.

There are no satisfactory standards for loss on ignition. The experience of the analyst is the best standard for odor and appearance.

HARDNESS.

Water is said to be hard when it precipitates soap to a greater extent than distilled water precipitates it. Hardness is due to the presence of bicarbonates, sulphates, etc., of metals like calcium, magnesium, iron, aluminum, etc. Below 300 parts per million is considered safe from a hygienic standpoint.

Water containing more than this amount is likely to prove unpalatable. The determination of hardness is of little value in a sanitary analysis except to indicate the nature of the soil through which the water passes. In a few instances where hardness is very high above the normal, it may indicate that seepage through masonry, barnyards, cesspools, etc., containing lime is taking place. In such instances there are usually sufficient chlorides and other impurities to condemn the water anyway.

In our determination of hardness we followed the well known method of Clark. The amount of soap decomposed by 100 mls. of the specimen is determined. The calcium carbonate equivalent of each milliliter of the soap solution is determined volumetrically by the use of a standard solution of calcium chloride prepared from calcium carbonate.

TURBIDITY.

Turbidity is due to suspended matter in water. Its importance will depend on the kind of matter suspended. The determination as customarily carried out tells us little or nothing about the kind of matter suspended. Therefore, the importance of this determination other than a rough index of the physical appearance is not very great.

After quickly subsiding material in the specimen is removed, a portion of the water is compared with an equal portion of distilled water in which a known quantity of some easily suspended material such as infusorial earth has been suspended. One gram of infusorial earth suspended in one liter of distilled water equals a turbidity of one thousand parts per million parts of water.

No standards are given. Most waters of excessively high turbidity would be unpalatable.

DISSOLVED OXYGEN.

Specimens of streams are tested for dissolved oxygen in order to determine the amount of self purification taking place. It is valuable if one is interested in knowing whether or not a stream that is being used at one point for sewage disposal has sufficiently purified itself by the time it reaches another point for its water to be used as a source of supply for a city without excessive cost for purifying. In the examinations of well waters it has little or no value since such waters are usually saturated with the oxygen of the air. For this reason we did not make the test for dissolved oxygen in our chemical examination of the specimens gathered for the data in this paper.

REACTION.

This determination is made in order to tell if the water is acid, alkaline, or neutral. In some cases it may be of value in determining the nature of the hardness present. It has some value in connection with the bacteriological examination as different organisms grow in alkaline media from those that thrive in acid media. Preliminary test of the specimens analyzed in this work indicated that the waters were practically neutral.

CONDUCTIVITY.

In this determination the conductivity of the water under examination is compared with the conductivity of distilled water using standard conditions in both cases. It may serve as an approximate index of the dissolved matter present. We were unable to make this test in our laboratory.

THE METHODS USED IN THE CHEMICAL EXAMINATION.

The methods used in analyzing the specimens of water gathered for the data in this thesis were those given in the yearbook of the Association of Official Agricultural Chemists with the exception of the procedure for the determination of hardness where the well known method of Clark was used. However, the determination of ammonia was modified by distilling a 250 ml. flask of water and shaking it thoroughly. A 50 ml. Nessler tube was filled from this flask and the ammonia determined as usual from this point.

The chemical examinations of the specimens were conducted in the quantitative laboratory of the Georgia State College of Agriculture under the supervision of Professor L. M. Carter.

THE BACTERIOLOGICAL EXAMINATION.

As bacteria occur everywhere, we know in reason that most waters contain them. Bacteria get into the water from the air, the soil, and from any object with which it comes in contact. The rope, dust flies, etc., are channels by which they get into shallow open wells. The number and variety of bacteria vary for each particular condition and place. Happily for man only a few species are harmful to him. Those that are harmful and are found in water usually get into it from the eliminations of body wastes. Even of those found in the eliminations of the body only a small per cent are pathogenic to man.

The routine examination calls for both qualitative and quantitative tests for basteria. The usual way of making a quantitative test for bacteria is to make a count. The importance of the bacterial count in checking on the efficiency of a filter is unlimited. And, it is valuable in determining how far out into a lake organisms from sewage contamination penetrate in order to properly locate an intake for a city water supply. In examining well waters its importance is much less. This is easy to understand since one well might have a high bacterial count with no harmful organisms present while another well might have a low count but have many harmful organisms. For this reason we did not include a bacterial count in our examination, as we relied on another test to give an approximation of the number of gas forming bacteria present. We were interested only in the bacteria which produced gas.

It is from the qualitative tests that the greatest benefit is derived from the bacteriological examination of shallow well waters. By qualitative tests we mean tests for certain general groups of bacteria. With the exception of Cholera vibrio we are unable to test for specific organisms in our present state of knowledge with any degree of certainty. Consequently, it is only in rare instances that tests are made for the individual pathogenic organism in examining specimens of water. Qualitative tests are made usually for the colon group of bacteria only. In some localities tests are made for sewage streptococci also. This test is included in the routine procedure in England. We did not carry our work farther than the usual tests for the colon group.

The colon bacillus group, as its name implies, inhabits the intestinal tract of animals. It includes many species, some of which are pathogenic to man. Among these are the typhoid bacillus, cholera bacillus, and those responsible for dysentery. These particular species of the colon group are eliminated from the intestinal tract of people infected with them. Their proportion is very low when compared with the total number of colon bacilli eliminated from human and animal intestinal tracts.

The general characteristics of this group are the fermentation of sugars with production of gas and acid, the formation of indol, the coagulation of milk, non-liquefaction of gelatine, motility, etc. All organisms of the colon group, pathogenic or otherwise, will respond to most of these tests. In water examinations little attention is paid to the specific organism that may be responding to the test. The mere fact that species of the colon group are present in relatively large numbers indicates that the water supply is being polluted by animal excreta. If there is a channel whereby animal excreta is reaching the water supply, it is reasonable to presume that excreta of humans suffering from intestinal diseases and therefore containing millions of pathogenic organisms will reach the water supply at some time or other. In addition, it is now well known that some apparently healthy people regularly eliminate typhoid germs from their system. This fact makes it all the more probable that typhoid germs will get into the water if some of the colon group is getting into it. For these reasons, the tests for the colon group are considered presumptive tests for pathogenic colon organisms. It is possible, positively to identify the organism or organisms responding to the test, but it involves more work and time than the results justify.

The specimens for the bacteriological examinations were taken in 250 ml., glass stopper, reagent bottles that had been previously sterilized. Most of the specimens were tested within an hour after taking. Where this could not be done, they were preserved in ice until they were examined. All of the specimens were examined within twenty-four hours after taking.

The test used in examining the specimens was one recommended by the United States Public Health Service. It was both a quantitative and a qualitative test. Five gas tubes containing in excess of twenty milliliters of lactose broth were sterilized at fifteen pounds pressure for thirty minutes. They were then each inoculated with ten milliliters of the specimen. These tubes were placed in an incubator and kept at a temperature of thirty-seven degrees for forty-eight hours. The percentage of gas was read at the end of the first twenty-four hours and again at the end of forty-eight hours. If gas was produced to the amount of ten per cent in any one of the five tubes at the end of forty-eight hours in the incubator, the water was considered polluted as it must have contained at least one colon bacillus in the fifty milliliters of the specimen. This is a very rigid test. Out of the twenty-two shallow wells examined, only one failed to show gas in at least one tube. The deep wells and the Athens city supply failed to develop gas in a single tube, however.

The bacteriological examination is the final criterion of the purity of a water supply. What the other tests in a sanitary analysis may indicate makes little difference if there are no colon bacilli present. The value of the bacteriological test is limited by the fact that it tells nothing of the history, nature, or probable source of the contamination when a water is found to be polluted.

THE PHYSICAL EXAMINATION.

In this examination the appearance, temperature, taste, odor, etc., of a well are considered. This examination is not very important in examining a group of shallow wells where only one examination of each well is to be made. But there are specific cases where it is of great value. For example, in examinating water recently contaminated by seweage, the odor may be of much value. Wells that change their temperature appreciably and quickly with the change of seasons are considered suspicious because of the probability of surface water streams flowing into the well through underground channels. However, it is necessary to make occasional examinations over a period of at least a year for the temperature curve of a well to be established. People naturally choose water that is as pleasing to their sense of sight and of taste as they reasonably can. Troops or prisoners in camp have little choice as to the physical properties of the water that they drink. Consequently, a physical examination should always be made of water that is to supply a camp site. The physical examination is of value also in testing the purity of waters that are to be used for boating and bathing. See Plate 1.

PLATE 1. *A lake used for bathing which is tested regularly to insure its purity. Notice the small house which contains the chlorination apparatus. Chlorine is added daily during the bathing season.*

Since none of the above cases were applicable to the work that we were doing and as a physical inspection of each specimen was made by the analyst while securing it, no detailed physical examination was undertaken in the analysis of the specimens used as data in the following pages.

THE MICROSCOPICAL EXAMINATION.

This examination has nothing to do with the bacteriological examination, although the name might imply a connection. It deals with the organisms in water other than bacteria. Many kinds of algae, diatoms, spiragyra, etc., inhabit surface waters in springs and impounding resevoirs. The usual procedure in the microscopical examination is to determine the number and kind of these organisms per milliliter of the specimen. Its value in the sanitary analysis depends on the fact that certain characteristic kinds of organisms occur in polluted waters that do not occur in unpolluted waters. In some localities, England for example, this examination is used extensively. It is not employed to a very great extent in America. We did not make this examination as the organisms tested for seldom grow in wells.

CHAPTER II

THE TERRITORY STUDIED AND TABLES OF DATA.

In making this study of the health conditions of the Negro as revealed by his water supply where shallow wells are the source, it was considered desirable to get information that would have widespread application. In Georgia, there are probably more than a hundred thousand shallow wells being used by negroes as a source of their water supply. To make a comprehensive study in the time at our disposal was obviously impossible. In order to get some information which would be to some extent applicable to large areas, we had to use a method that would reduce the routine laboratory work and still give a reasonably correct view of the general condition of the negro's water supply.

Our method of gathering data was to pick out communities that we judged to be typical of the conditions prevailing in large areas. The communities were selected according to variations in the physical conditions affecting the water supply, such as density of population, soil type, drainage, water level, type of well, etc. As we wished to study the condition of the water supply in as many communities as possible we did not attempt to analyze a specimen from every well in a community. After making a preliminary survey of the community we chose a number of wells which we thought would represent a cross section of the wells in the community. By this method we were able to study several communities, each representative of a type of conditions existing in large sections of the State.

The physical conditions in Georgia as they affect the water supplies where shallow wells are used as the source may be easily divided into three groups. The mountainous region in the Northern part of the State constitutes one group; the foothills, or Piedmont Plateau, a second group; and the Coastal Plains a third group. Most of the negroes of Georgia live in the Piedmont Plateau and Coastal Plains regions. For this reason and because of the inconvenience in getting specimens, we did not study the shallow wells of a mountainous community.

Insofar as the educational and economic level of the negroes is concerned, there is little variation that would be significant in regard to the condition of the water supplies in the two regions in which we studied.

Five of the eight communities in which we studied the shallow well water supplies were located in Athens and its vicinity. We selected these communities because they appeared to be fairly typical of many similar communities located in the Piedmont region and because of the convenience in getting specimens, the accessibility of the laboratories, etc. Also, data in regard to the health conditions of the negro as revealed by his water supply may be appropriately added to the information about negroes in Athens and Clarke County gathered by previous Phelps-Stokes Fellows. Two of the communities which we studied in the Coastal Plains were located in Laurens County. One was at Dudley and the other in its vicinity. The analyst had lived in this County for a number of years and believed the conditions of the water supplies were approximately characteristic of much of the upper part of the Coastal Plains. The other community was located at Augusta. In this community we were able to study the driven type of shallow well. Lack of time and inaccessibility prevented our making a study in the lower part of the Coastal Plains. The local conditions in each community will be discussed later. Before we begin a discussion of the communities which we studied, we will discuss a few water supplies of known purity.

SOME WATER SUPPLIES OF KNOWN PURITY.

Specimen number seventy-five in the following table was taken from the city water supply of Athens. This water is secured from a small stream about two miles north of the plant. It is pumped into a large settling lake where it remains for about two months. Plate 2.

While in storage most of the ammonia and nitrites are converted into nitrates and most of the mud settles out. Many bacteria die during storage also. The water is then treated with chemicals to coagulate the suspended matter. It is allowed to remain for about a day in large vats while the coagulated material settles out. Plate 3.

PLATE 2. *The settling lake at the Athens municipal plant.*

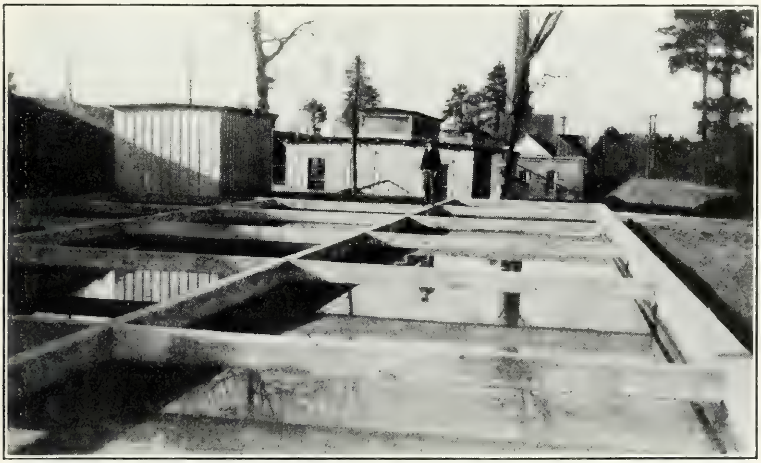

PLATE 3. *Settling vats at the municipal plant.*

From the vats the water is carried through filters. Before being pumped into the standpipe for distribution it is treated with chlorine which is supposed to kill all harmful bacteria which might have passed the filters. Such procedure will furnish as pure water as it is practically possible to provide in wholesale quantities. Frequent bacteriological tests are made to check the efficiency of this procedure.

We included an analysis of a specimen of the Athens city water supply in order to call attention to the careful manner in which the water is treated. Cities generally give their water supplies the same or similar careful treatement.

Also, it may interest the reader to compare the analysis of the city water with the analyses of the shallow wells in the city or its vicinity. In making such a comparison it should be remembered that chlorine has been added; and, that both chlorine and nitrates are residual from past contamination. Since all disease germs which might have come into the water with this past contamination have been destroyed by the above treatment, these tests lose most of their significance.

Specimen number seventy-six of this table was taken from the flowing well used by the City of Dublin as a source of its supply. This well is about five hundred feet deep. It is protected from surface contamination by an iron casing. Such water is about as sanitary as can be found in nature. No germs pathogenic to man are likely to survive long at such depths and any contaminating matter which might get into the well through the top would be washed out by the flow of the water. The water probably remains underground for months before coming to the surface. Most germs die in such lengths of time. However, to insure its purity it is treated with chlorine before being distributed for use.

As has been pointed out while discussing the nitrite test, the high results for nitrates is explained on the theory that nitrites were oxidized to nitrates in some manner. The nitrates and chlorine in this water are residual from past contamination just as in the Athens city water.

Specimen No. 78 was from a drilled well at Dudley, see Plate 5. This well is over four hundred feet deep. It is not an artesian well. It was dug as a source of the municipal water supply. As the iron casing is closed at the top by means of a pump, the sanitary condition of this water supply is approximately perfect. It may interest the reader to compare the analysis of this well with the analyses of the shallow wells in and around Dudley.

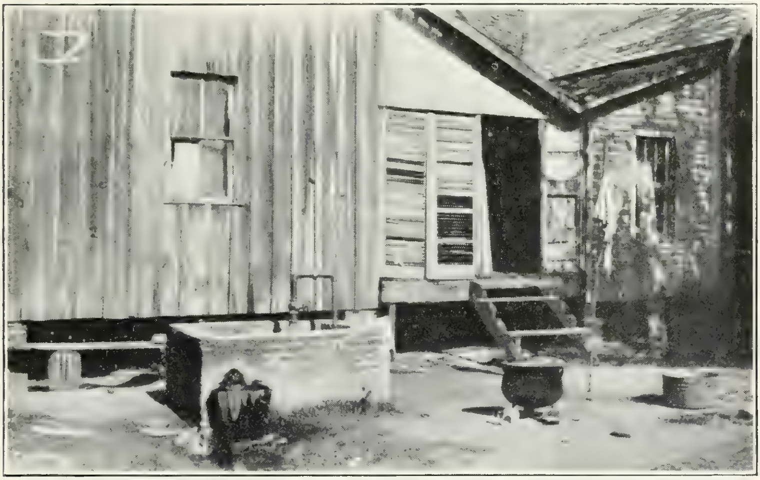

PLATE 4. *This private artesian well is being used by negroes. It is the source of specimen No. 77.*

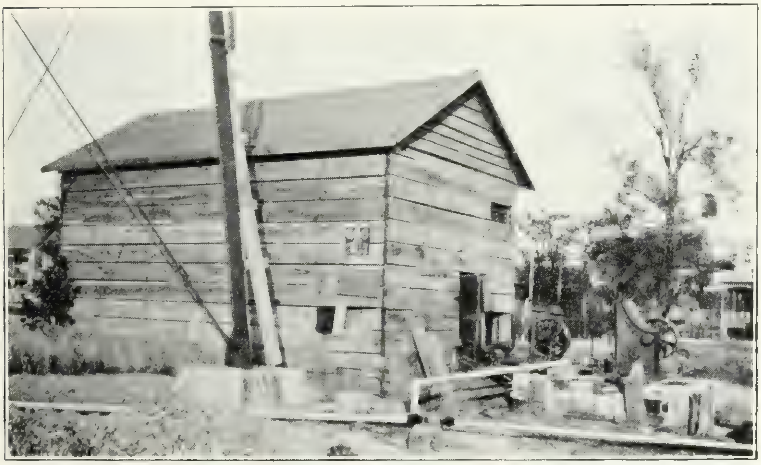

PLATE 5. *The Dudley well.*

The hardness of the water is usually an objectionable feature where deep wells are used for domestic purposes such as laundrying, bathing, etc. It is seldom hard enough to be harmful to health. In some cases this objectional feature is met by having a shallow well to supply water for laundrying, while the deep well water is used for drinking and bathing.

We took specimen number forty-five from a driven well in the Augusta community. Although we were unable to make a bacteriological examination of this water, we believe it to be safe from our chemical examination and the sanitary survey. It is reported in the tables of data about the Augusta community. Compare it with the other waters of known purity and then compare it with the shallow wells in the Augusta community.

TABLE NO. 1*

Some Water Supplies of Known Purity.

Specimen number	75	76	77	78	45	38
Sanitary score %	95	100	100	100	80	70
Free ammonia	.060	.025	.030	.000	.050	.000
Album. ammonia	.075	.125	.010	.000	.000	.060
Nitrites	.0008	.0030	.0000	.0000	.0000	.0020
Nitrates	.000	.600	.000	.050	.150	.350
Chlorine	7.2	6.5	8.7	5.8	5.0	5.2
Oxygen required	.230	.050	.260	.355	.875	.125
Total solids	94	85	276	165	23	58
Loss on ignition	23	25	43	72	5	27
% of discoloration	25	25	25	20	25	30
Hardness	24.7	144.8	170.5	116.7	25.7	11.6
Turbidity	5	5	20	5		40
Bact. Exam	0	0	0	0		0
Analyst's opinion	+	+	+	+	+	+

*EXPLANATORY NOTES ON THE TABLES OF DATA

The accompanying tables of data are self explanatory for most of the items included in them. The results of the tests made in the analysis of the various specimens are arranged in the order of their importance beginning with the sanitary survey.

The results of the chemical examination are given in parts per million except for the amount of discoloration which developed on ignition. This is given in per cent. The system of reporting the results of chemical tests in parts per million has come to be almost universally used by water analysts. Although the English gallon is the common unit for measuring water in this country, "parts per million" will be less confusing to the majority of people than "grains per gallon" would be.

The number of tubes which developed more than ten per cent of gas is given under the bacteriological examination.

The plus sign (+) is used to indicate a water supply which is considered by the analyst to be pure. The minus sign (–) is used to indicate a water supply that is judged to be impure. The question mark (?) indicates water which is of questionable purity.

The last specimen in this table, No. 38, was taken from a shallow rural well near Athens. This well was dug in micaceous soil. Drainage is good. The water level is about thirty feet below the surface of the ground. The sanitary conditions may be judged from Plate 6. The chemical test indicated that there were appreciable amounts of nitrites present, but the bacteriological examination failed to indicate the presence of any gas forming organisms. Compare the analysis of this well with the analyses of other shallow wells located in Athens and vicinity.

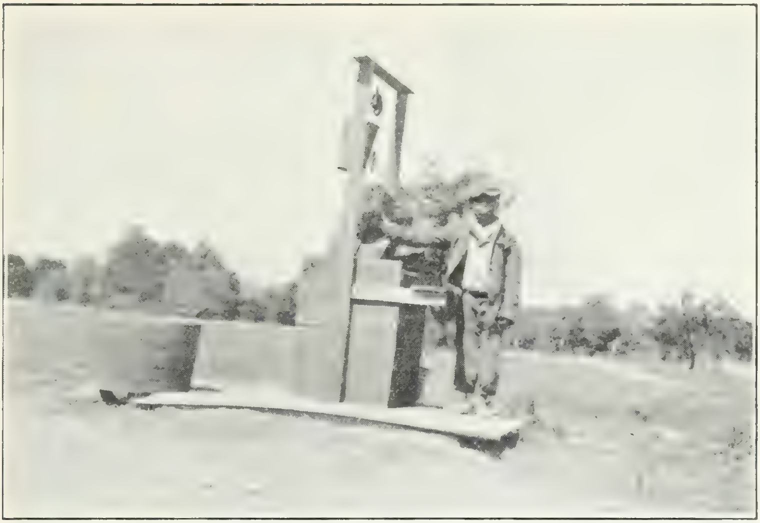

PLATE 6. *Source of specimen No. 38.*

THE COMMUNITY IN WEST ATHENS.

In our preliminary survey of Athens we found that fully eighty per cent of the negroes had access to the city water mains and were using city water. About half of the negoes using shallow wells as a source of their water supply live in the western part of Athens. About one-fourth of them live in the eastern part of the city and the other fourth are scattered about in various parts of the city. One type of conditions is represented in the West Athens community and another type is represented by the East Athens community. We made a study of both communities. We did not make a study of the scattered wells because those situated west of the Oconee River are generally similar to those in the community that we studied in West Athens and those situated east of the river are similar to those that we studied in the East Athens community.

The community in West Athens is situated around the western terminus of Broad Street. It extends northward from the western end of Baxter Street nearly to Hill Street. About twenty per cent of the negroes of Athens live in this community. Approximately half of them have connections with the city water mains that have been laid through the center of this community. The other half of the negroes who live on either side of the section supplied with city water depend on shallow wells for their domestic water supply.

For no apparent reason the houses in this community are crowded together along a few streets, although abundant building room is available at reasonable prices a few hundred yards away. The small ill-repaired houses are built on lots fifty feet wide and a hundred feet long with few vacant lots on a street. In addition to the house the privy, chicken house, and

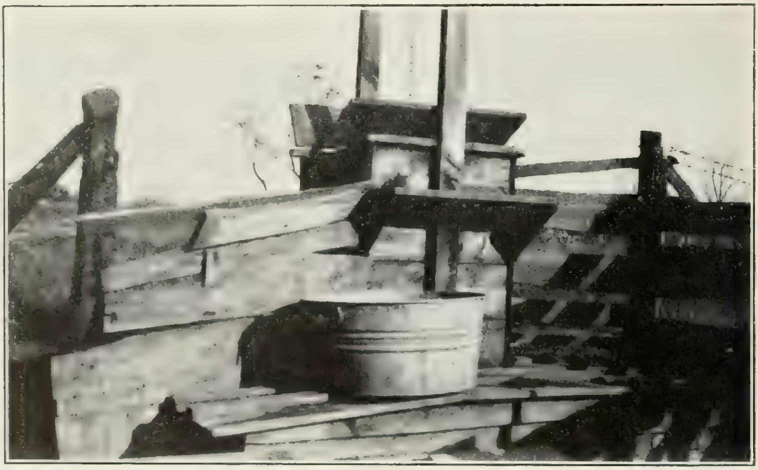

PLATE 7. *A well dug within three feet of a pig pen and stableyard on one of the small premises. Source of specimen No. 6, Table 2.*

well are located on the same lot. If the occupant happens to be a drayman or a gardener who owns a horse, a stable is crowded on the same lot also. Some of the negroes have pig pens on their premises. See Plates 7 and 8. Perhaps, the worst conditions are found on rented premises. On one street three houses have been built on a double lot only a hundred feet in width. All three of these houses use a common well [which has been condemned by the Board of Health (see Plate 17)] and a common privy which is shown in the following picture, Plate 9.

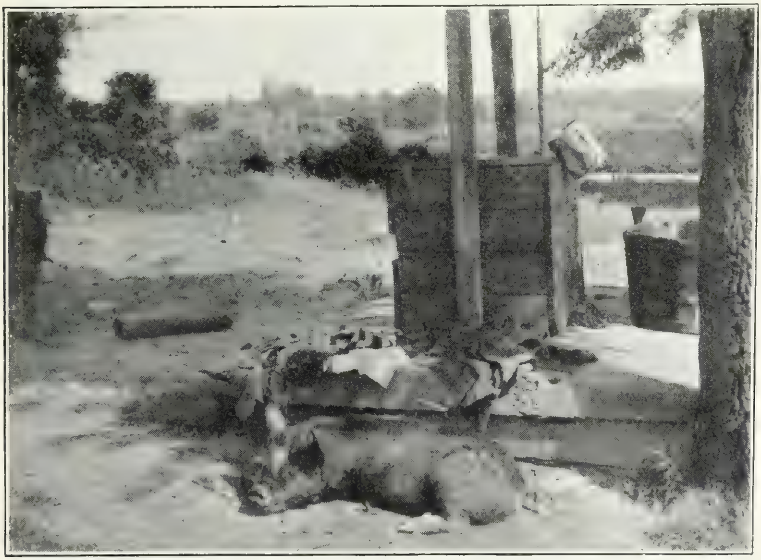

PLATE 8. *Wallowing by a well on the outskirts of Athens.*

The sanitary conditions of the premises are very poor, see Plate 10. Much trash and garbage can be seen in the yards and under the houses. The privies are of the dug pit type. They are very unsightly in appearance, but the pits are generally fly proof. While this type of pit for disposal of excreta is recommended by health authorities, they make contamination of the water supply almost certain when they are dug so near the wells especially in the type of soil in which both the pits and the wells are dug.

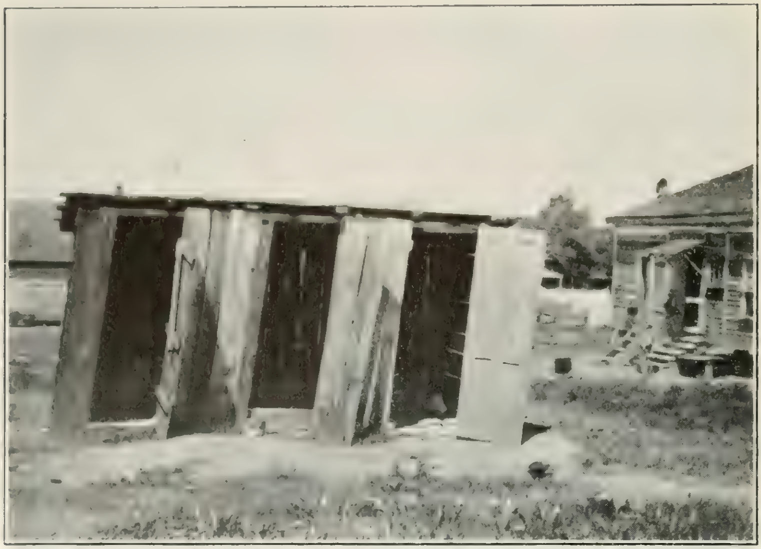

Plate 9. *A common privy. A menace to the health of an entire community.*

The soil is of the friable clay type. It contains much rock. Numerous rocks may be seen on the surface and sticking out of the sides of the wells. The drainage is fair. However,

Plate 10. *An average backyard.*

some of the houses are built in such a manner that their wells are liable to receive cumulative quantities of contaminating material from houses above them, Plate 11. The water level in average weather is approximately twenty feet below the surface of the ground.

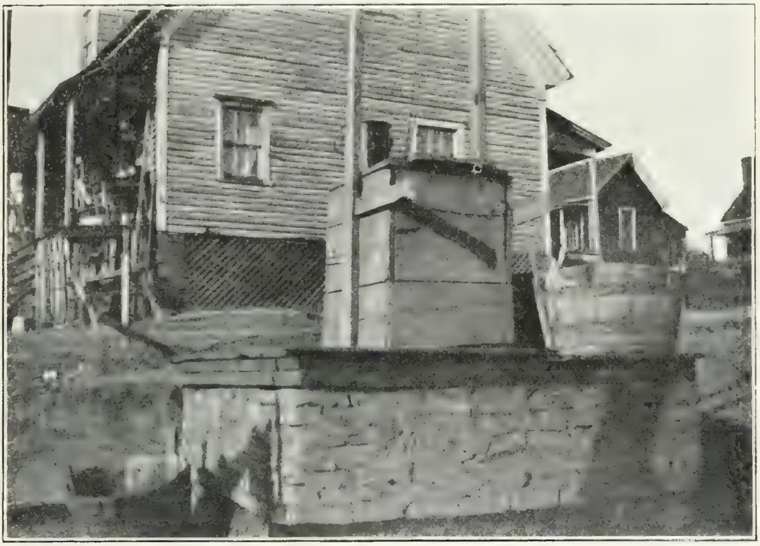

PLATE 11. *A well which is liable to receive contaminating material from the houses above it. Source of specimen No. 5, Table 2.*

The general physical conditions affecting shallow well water supplies are below the average of the Piedmont region. The effect of the poor physical conditions is intensified by the density of the population.

The wells of this community are of the shallow dug type. A large excavation about six to eight feet square is made in the ground at the surface. The width is gradually reduced as the well is dug deeper if rocks are not encountered. It seems that it is the rule to start the well wide at the surface in order to have room to dig around rock and remove them or to dig deeper on one side. This wide opening at the surface is covered by a platform of boards. In the center of the platform a square box covered by a trapdoor is constructed to permit water to be drawn. A rope, bucket, and tackle constitutes the ap-

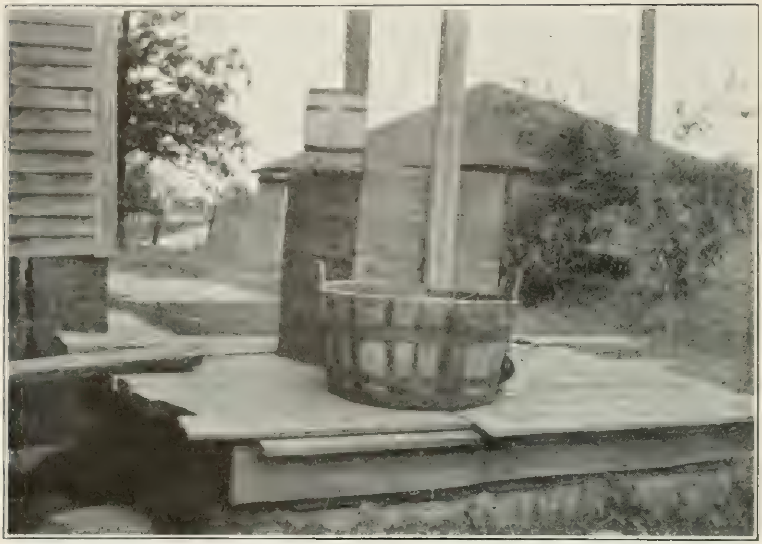

PLATE 12. *A typical well of the Piedmont Plateau.*

paratus for drawing the water from the well. This is the typical type of well used in the Piedmont region, see Plate 12.

Such wells are very unsanitary. The platform of boards is

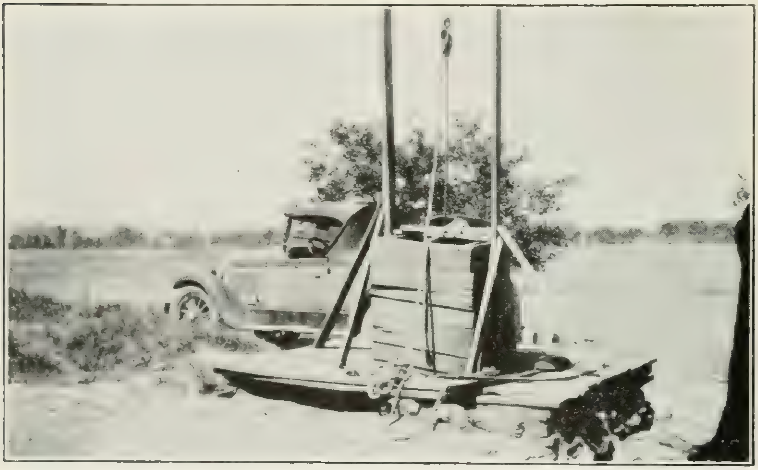

PLATE 13. *Many wells in as poor condition as this one are seen in the Piedmont region.*

never water proof. About half of the wells studied had platforms that had begun to decay. Some of them had decayed to such an extent that there was danger of stepping through them, see Plate 13. The person drawing water has to stand on the platform to draw it, see Plates 14 and 15. Any water spilled from a leaking bucket or otherwise will wash contaminating material brought to the platform on the shoes, by dust, poultry, etc., directly into the well. The rope furnishes an excellent means by which bacteria may enter the well. Moreover, the trapdoor covers are neglected to a greater degree than the platforms. Ninety per cent of the doors are not proof against flies and dust, which is the principal reason for having a cover.

PLATE 14. *One of the very unsanitary wells in the Piedmont.*

The Board of Health of Athens has condemned a number of the wells in the West Athens community within the last two years, Plates 16 and 17. In spite of this fact, the negroes continue to use them for domestic purposes. Rock Spring, located in this community, was condemned, but several negro families are using the water according to statements of children and the evidence from paths leading to and from it.

No actual count was made of the number of wells in this community. They were estimated at fifty. Specimens were

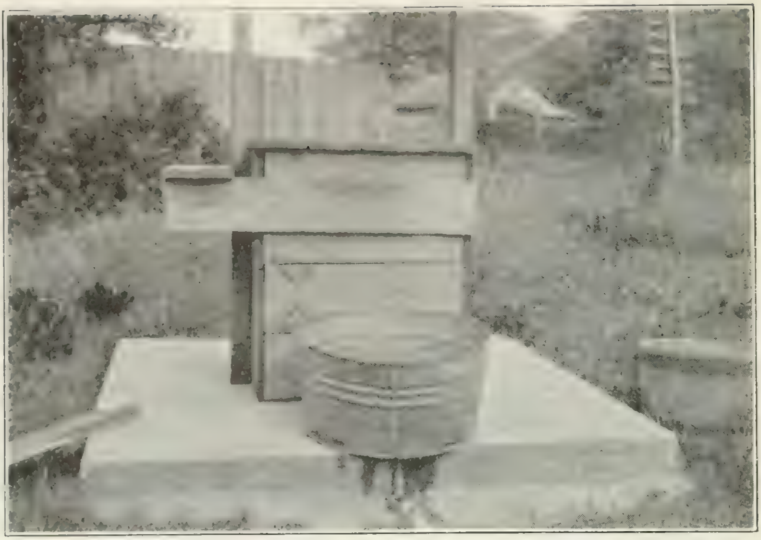

PLATE 15. *More wells of this type are needed in the Piedmont. Concrete platforms are much more sanitary than boards.*

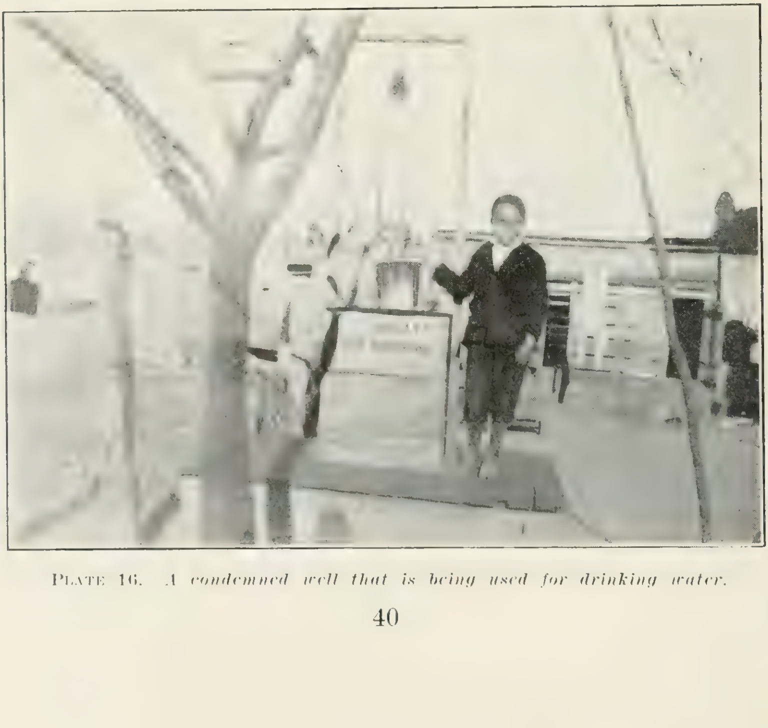

PLATE 16. *A condemned well that is being used for drinking water.*

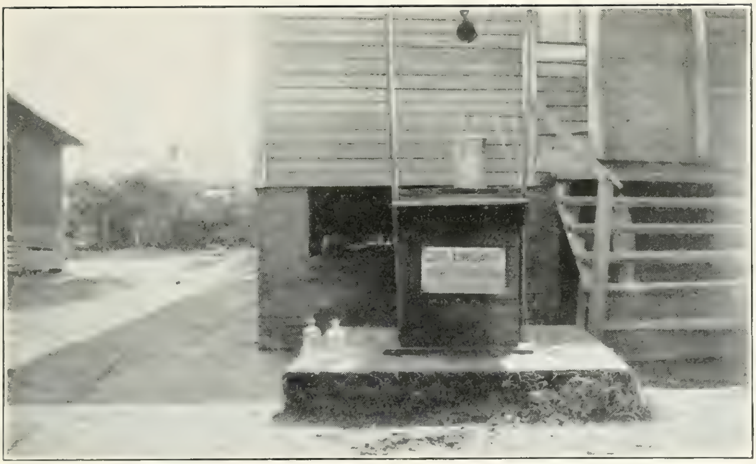

PLATE 17. *The poor platform is enough to condemn this well. It is still being used by three families of negroes.*

taken from twelve of the wells. They were selected as representative of this community.

This community is typical of others which are located on the outskirts of cities of the Piedmont region where physical conditions are poor and the population dense. From surveys made in several of them it appears that the negro's water supply is generally neglected by the water boards as it is in this Athens community. Negroes living on the outskirts of the cities seldom have city water connections. In some of these communities the physical conditions are equally as poor as those in this community. In cities with a population below three thousand nearly all the negroes use shallow wells as the city mains are not extended to the negro communities in the small cities.

The results of the analyses of the specimens taken in the West Athens community are given in the following tables. A discussion of the results is given immediately after the tables.

TABLE NO. 2.

The Community in West Athens

Specimen number	1	2	3	4	5	6
Sanitary score %	60	70	70	50	55	75
Free ammonia	.100	.030	.060	.050	.025	.045
Album. ammonia	.070	.050	.040	.070	.025	.075
Nitrites	.0010	.0000	.0060	.0035	.0000	.0038
Nitrates	.090	.250	.870	.640	.450	.360
Chlorine	7.7	14.5	29.0	39.5	17.0	10.2
Oxygen required	.265	.130	.630	1.120	.565	.460
Total solids	128	76	105	37	170	90
Loss on ignition	39	24	65	23	65	63
% Discoloration	50	75	35	35	50	59
Hardness	8.8	45.6	39.7	74.9	24.9	16.2
Turbidity	5	10	35	5	15	10
Bact. exam.	4	3	1	5	2	5
Analyst's opinion	—	—	—	—	—	—

TABLE NO. 3.

The West Athens Community, Continued

Specimen number	7	8	9	10	11	12
Sanitary score %	50	40	60	50	65	40
Free ammonia	.060	.020	.010	.020	.000	.075
Album. ammonia	.080	.060	.050	.090	.060	.080
Nitrites	.0020	.0002	.0008	.0002	0000	.0160
Nitrates	.610	.025	.450	.650	.080	.600
Chlorine	19.5	15.0	13.0	15.5	12.0	37.0
Oxygen required	.450	.395	.150	.750	.700	.800
Total solids	110	146	63	112	51	270
Loss on ignition	54	70	27	85	35	73
% Discoloration	35	75	30	30	40	35
Hardness	36.8	29.4	9.2	39.2	15.4	75.9
Turbidity	20	30	15	50	5	30
Bact. exam.	—	—	5	5	5	5
Analyst's opinion	—	—	—	—	—	—

We were unable to make a bacteriological examination of specimens number 7 and 8 in Table 3. For several reasons we were unable to begin our bacteriological examinations until more than half of the chemical examinations had been made. Consequently we were unable to examine all of the specimens for bacteria.

All ten of the wells which were examined bacteriologically were found to have at least one colon bacillus in fifty mls. of the water. Six of them were found to have one in every ten mls. of the water. This indicates that these wells are receiving contaminating material which contains gas forming organisms. We would be inclined to think that the well from which specimen Number 11 was taken was receiving the bacteria from dust, the rope, etc., because the chemical tests failed to indicate that contamination from impure surface or underground water was taking place. The tests for free ammonia and nitrites were negative while the test for chlorine, albuminoid ammonia and nitrates are low. The appreciable oxygen requirement seems to indicate that some organic matter of vegetable nature is getting into the water. Specimen Number 2 is similar to specimen Number 11.

Most of the other wells appear to be receiving or to have received contamination involving animal excreta. This is evident from the high chlorine content. The normal chlorine content for this community is approximately 5 parts per million. Any of the wells with a chlorine content above 15 parts should be suspected of receiving contamination from animal excreta.

The free ammonia in specimen Number 1 might indicate recent contamination in which the ammonifying organisms were actively at work. The low chlorine content seems to indicate that the contamination is of vegetable nature.

Specimens 4 and 12 appear to be receiving continuous contamination of animal excreta as indicated by the appreciable quantities of all four forms of nitrogen and the high chlorine content. Contamination from a privy is to be suspected in cases like these.

Specimen Number 3 is an example of a well in which the nitrifying organisms appear to have converted the nitrogen contaminating matter into nitrites and nitrates. In a few days this well probably would give very low indications of ammonias and nitrites, while it would be high in chlorine and nitrates.

Specimens 5 and 10 appear to have received contamination of animal nature in the past as the chlorine and nitrates are appreciably high. Ten appears to be receiving some vegetable matter as it has a considerable oxygen requirement. Contamination will probably occur again in these wells through the same channels that it has occurred previously.

It is hard to form a standard for oxygen requirement in Georgia communities as the amount of organic matter occurring naturally is very small. The standards set by analysts who worked in areas where the amount of natural organic matter is much greater than in these communities are not applicable.

Specimen 6 appears to have recently received contamination of both vegetable and animal nature. The tests for all four forms of nitrogen indicate that appreciable quantities are present. However, the oxygen requirement and the chlorine content are not very high. Such a combination indicates contamination of both animal and vegetable nature with a slight preponderance of vegetable matter. Contamination from a stable is to be suspected in cases like this. Specimen 9 resembles specimen 6 except that the contamination took place farther back because the ammonias and nitrates have been oxidized to nitrates.

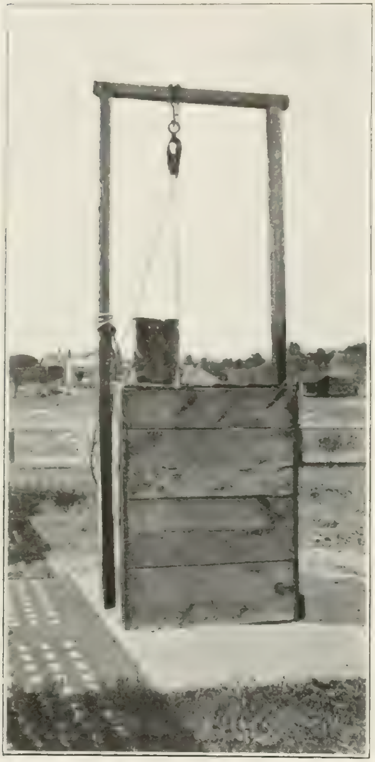

PLATE 18. *Source of specimen No. 18. The excellent distribution of houses may be seen in the background.*

THE EAST ATHENS COMMUNITY

This community is located on the Winterville road a short distance beyond the junction with the Lexington road. About five per cent of the negroes of Athens live in this community. It is a recently built community. It is growing rapidly. We may expect this section to grow much faster than other negro communities in Athens, as there is unlimited suitable space for expansion. See in this connection, Plate 18.

The housing conditions are better than in most surburban negro communities. The houses are larger, of better construction, and are not as crowded as those in the West Athens community. (Plate 18). They appear to be kept in good repair.

The sanitary conditions are much better also. The building lots are larger and the wells and outhouses are better situated in relation to each other. The premises are cleaner and appear to receive more attention than those in the West Athens community.

The wells are of the type described as typical of the Piedmont region. The platform of boards is as unsanitary as those of the West Athens community, see Plate 19. Density of population and poor physical conditions of soil and drainage operate to make the well unsafe in th ecommunity in West Athens while a less dense population and better physical conditions of soil and drainage tend to make the wells safer in the East Athens community.

PLATE 19. *An unsanitary well in East Athens, Specimen No. 13.*

The soil in this community is a red compact clay type. Few rock are mixed with it. Drainage is good and the houses are arranged in such a manner that contaminating material will be carried away from the wells. Most of the houses are built on long gentle slopes with none of the houses built one above another.

There are about thirty wells in this community. Six of them were selected by us as being representative of the conditions in this community.

The community is a good example of a negro community on the outskirts of cities where the physical conditions are favorable. Even in the event of rapid growth and keen competition for building space the conditions in this community would remain fairly favorable because of the good soil type and elevation of the entire locality. There are no swampy spots for the negro to occupy.

The following table, No. 4, gives the results of the analyses made in the East Athens community.

TABLE NO. 4.

East Athens Community

Specimen number	13	14	15	16	17	18
Sanitary score %	60	70	65	60	50	80
Free ammonia	.060	.025	.000	.000	.050	.000
Album. ammonia	.125	.060	.050	.020	.090	.025
Nitrites	.0000	.0000	.0000	.0000	.0010	.0000
Nitrates	.400	.350	.200	.150	.350	.095
Chlorine	40.0	8.5	9.2	14.5	13.2	12.2
Oxygen required	.730	.090	.075	.350	.235	.050
Total solids	78	104	92	91	55	59
Loss on ignition	17	51	75	28	25	35
% of Discoloration	70	30	50	30	35	35
Hardness	19.1	11.0	9.6	13.2	16.6	16.5
Turbidity	25	5	10	10	5	5
Analyst's opinion	—	+	+	?	?	+

The low chlorine content of all of these wells except one forms a striking contrast to the high chlorine content of most of the wells in West Athens. The two wells in the questionable class were placed there by the analyst mainly because of the chlorine content and the poor sanitary condition of these wells. The three wells that were judged to be safe appear better from the chemical examination than some of the wells that are known to be pure. However, the analyst doubts that the questionable wells and all of those found to be safe from the chemical examination would pass the bacteriological test because of the poor type of platforms and drawing apparatus in use

THE WINTERVILLE COMMUNITY.

Winterville is situated in the eastern part of Clarke County on the Georgia Railroad. The city limits extend to the county line of Oglethorpe County. The census of 1920 gives the population of this town as five hundred and four. About one-third of the population at the present time are colored people.

The location of the town is good. The gentle slope on which it is built gives excellent drainage. The soil is of the compact clay type. The water level is about twenty feet below the surface of the ground. The houses are not crowded and general sanitary conditions are good. Negroes have built on the least desirable spots in the town, however.

There is nothing to distinguish it especially from the usual rural village in which there are churches, schools, a postoffice, several general stores and depot. We think that it is typical of several hundred towns and villages in the Piedmont region.

We selected nine of approximately forty wells in and immediately around Winterville. They were of the usual type seen in the Piedmont region. See Plate 20 in this connection.

The following Tables 5 and 6 contain the results of the analyses made of specimens taken in the Winterville community.

TABLE NO. 5.

The Winterville Community.

Specimen number	19	20	21	22	23	24
Sanitary score %	70	60	60	60	50	70
Free ammonia	.400	.000	.050	.050	.100	.100
Album. ammonia	.050	.100	.000	.040	.200	.075
Nitrites	.0000	.0010	.004	.0005	.0004	.0005
Nitrates	1.200	.350	.010	.030	1.500	.300
Chlorine	19.5	5.6	9.3	11.0	94.2	10.0
Oxygen required	.150	.350	.200	.000	1.000	.150
Total solids	142	55	72	125	585	108
Loss on ignition	80	35	49	38	283	76
% of Discoloration	30	60	60	65	90	50
Hardness	47.1	11.0	17.2	9.3	44.1	22.8
Turbidity	5	16	20	55	100	150
Analyst's opinion	—	+	+	+	—	+

TABLE NO. 6.

The Winterville Community, Continued

Specimen number	25	26	27
Sanitary score %	60	55	40
Free ammonia	.200	.125	.150
Album. ammonia	.090	.250	.050
Nitrites	.0005	.0130	.0030
Nitrates	.100	1.350	3.200
Chlorine	12.0	9.0	68.0
Oxygen required	.350	.850	.050
Total solids	52	182	233
Loss on ignition	23	97	52
% of Discoloration	30	60	25
Hardness	19.8	41.2	57.4
Turbidity	5	80	90
Analyst's opinion	—	—	—

From the large amounts of free ammonia and nitrates found in specimen No. 19, it seems that intermittent contamination of the well is taking place. Most of the albuminoid ammonia and all of the nitrites of previous contaminations have been oxidized to nitrates. The free ammonia appears to indicate that large amounts of contamination in which ammonifying organisms are at work have recently entered the well.

Plate 20. *Winterville wells.*

The high chlorine content together with appreciable quantities of all the forms of nitrogen except nitrites which are probably temporarily low seem to indicate that specimen 23 is being contaminated continuously by animal excreta.

Specimen 24 has appreciable amounts of free and albuminoid ammonia, but the chlorine content and the nitrates are not very high. This indicates that some vegetable matter is getting into the well. Only a bacteriological test could tell whether or not colon bacilli are getting in with contamination of this nature.

Specimen 25 appears to have just received contamination in which free ammonia was present. Specimen 26 is receiving contamination of vegetable nature as indicated from the high tests for all the forms of nitrogen and low chlorine content. Specimen 27 is receiving continuous contamination of animal nature as indicated by the tests for nitrogen and the high chlorine content.

THE RURAL COMMUNITY BETWEEN EAST ATHENS AND WINTERVILLE.

This community is situated along the Athens and Winterville road. The soil conditions, drainage, water level and other physical conditions are approximately the same as in the East Athens and Winterville communities. The difference in the conditions in the three communities arises principally from the difference in the density of population.

The rural negro has some advantages over the surburban and village negroes. His home is generally built on a desirable location with plenty of yard space. The wells in the rural section are usually better situated in relation to the other houses than in the city or village. The domestic animals of the negro tenant are generally kept in pastures. Farm stock is left at the landlord's barn at the end of the day's work. The barnyard of negro farm owners or renters is usually suitably situated in relation to the well. This is a pleasant contrast to the manner in which the surburban or village negro crowds a pig pen, cow stable, horse stable, chicken house, privy, dwelling house, and well on an eighth of an acre. Many of the negro houses in the rural section do not have even a chicken house on the premises. Neighbors are at a safe distance also. The old type of negro quarters with its rows of closely spaced cabins has disappeared from most rural sections of Georgia.

The conditions affecting the wells in the rural communities are for the most part physical. They are fairly uniform over large areas on this account. In view of this fact we devoted most of our time to work in the surburban and village com-

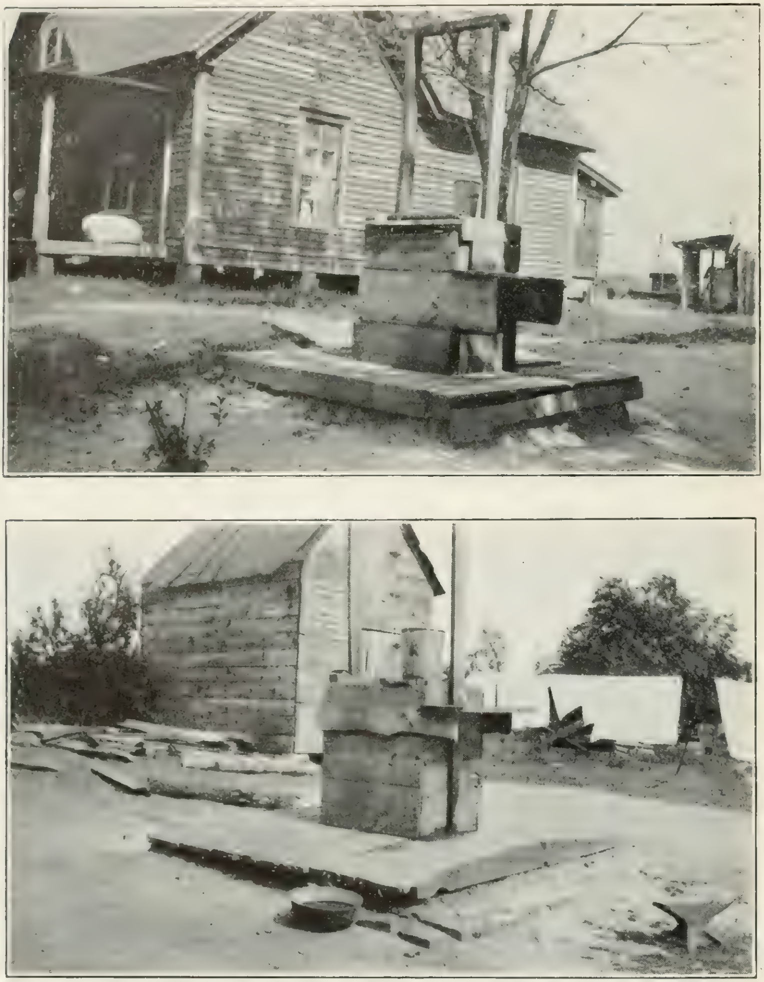

Plate 21. *Typical rural wells.*

munities where greater variation is found between the communities although great uniformity is found in a given community.

Poor care of the well is characteristic of the rural community just as it is characteristic of the suburban and village communities. Contamination entering from the top is largely responsible for so many of the rural wells proving unsafe. Leaves, trash, and surface water contaminates many rural wells. See Plate 21 for typical rural wells.

We studied eleven of the rural wells of Clarke County. We believe them to indicate approximately the condition of thousands of similar wells in the Piedmont Plateau region. The results of the analyses of the rural wells are given in the following tables, 7 and 8.

TABLE NO. 7.

The Rural Community Between East Athens and Winterville.

Specimen number	28	29	30	31	32	33
Sanitary score %	65	60	60	50	50	40
Free ammonia	.200	.100	.110	.050	.000	.000
Album. ammonia	.175	.020	.050	.075	.020	.040
Nitrites	.0000	.0000	.0018	.0010	.0000	.0020
Nitrates	.050	.030	.250	.000	.080	.300
Chlorine	4.0	4.8	3.2	3.2	8.4	14.3
Oxygen required	.300	.050	.200	.010	.025	.060
Total solids	41	40	56	45	55	84
Loss on ignition	37	15	49	30	40	48
% of Discoloration	70	35	30	30	20	35
Hardness	14.6	14.1	5.2	12.0	13.9	7.8
Turbidity	10	70	60	25	110	45
Analyst's opinion	?	+	?	+	+	?

TABLE NO. 8.

The Rural Community Between East Athens and Winterville, Continued

Specimen number	34	35	36	37	38
Sanitary score %	30	50	75	70	60
Free ammonia	.020	.120	.050	.000	.000
Album. ammonia	.060	.020	.100	.060	.020
Nitrites	.0000	.0000	.0000	.0020	.0050
Nitrates	.025	.015	.090	.350	.200
Chlorine	12.7	21.0	31.5	5.2	3.0
Oxygen required	.150	.425	.600	.125	.010
Total solids	141	73	147	58	23
Loss on ignition	33	50	32	27	15
% Discoloration	65	70	50	35	45
Hardness	40.5	31.9	34.5	11.6	4.6
Turbidity	80	5	300	40	180
Bact. exam				0	4
Analyst's opinion	+	—	—	+	—

With two exceptions all of these wells have a low chlorine content. Compare them in this respect with the wells in the suburban and village communities. The wells that have appreciable amounts of nitrogen appear to be receiving contamination of vegetable nature. While such contamination is not safe, the danger of getting disease germs into the system from drinking water polluted by purely vegetable contaminating matter is much less than from drinking water polluted by animal excreta contamination.

Proper care of the wells would improve the water supplies of the suburban, village, and rural communities, but the rural community can improve its water supply much more effectively than the other communities because conditions are so much better in the rural community.

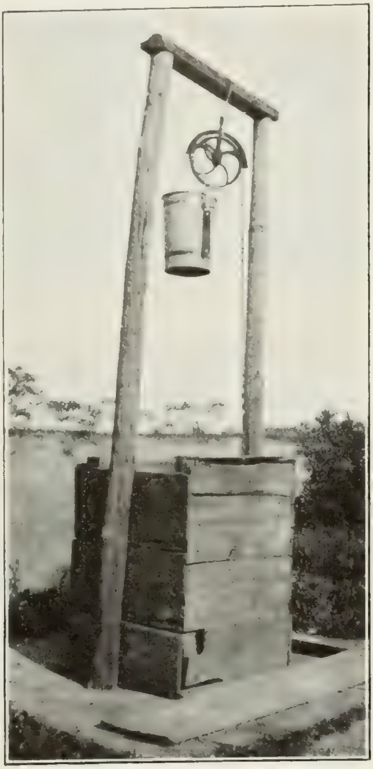

PLATE 22. *Specimen No. 39 was taken from this well which is bein used by two negro families*

To illustrate, a concrete platform that will prevent surface water from entering the well and a trapdoor that will effectively cover the opening for drawing is generally all that rural wells require to make them safe. In the densely populated community in the city such an arrangement would be worthless against underground seepage from a nearby privy.

THE WATKINSVILLE COMMUNITY

Watkinsville is the county seat of Oconee County. The population is given as four hundred and sixty-five by the census of 1920. Few negroes live in Watkinsville at the present time. According to information furnished by white people who have been living in the town for a number of years, most of the negroes have emigrated to Northern cities.

The general physical conditions affecting the water supplies are good. The soil is of the compact red clay type with few rock on the surface. Dainage is excellent. Houses are not crowded and are favorably located. The wells have been properly located in relation to the houses. This community is situated on a hill which made it necessary to dig several feet deeper in order to get water than in most communities in this area. Sanitary conditions are normal.

The condition of the wells is below the average for the Piedmont region. The unsanitary well box described as characteristic of the Piedmont region is at its worst in this community. Not a platform on any of the wells studied in this community was water proof. Some of them had decayed to such an extent as to be dangerous. Plate 22 is a picture of such a well. One of the wells had a concrete platform of good construction. This platform had been ruined by a hole cut into it to install a pump, Plate 23. We selected six wells from about twenty in this community as representative of the conditions of the wells in it.

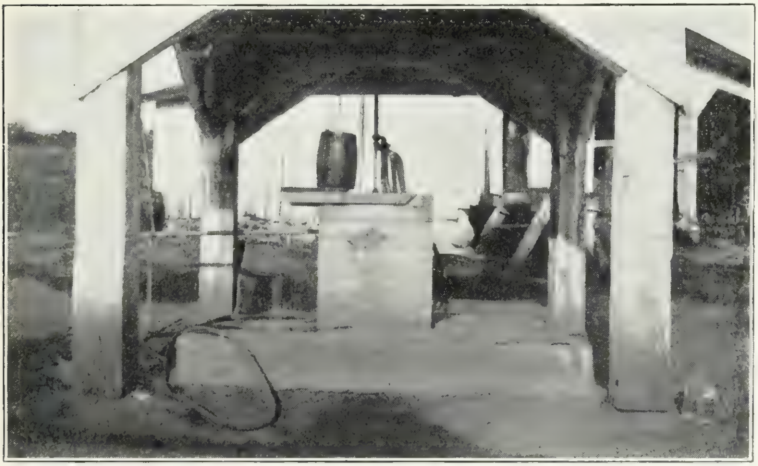

PLATE 23. *The Oconee convict camp well.*

The results of the analyses made in the Watkinsville community are given in Table 9. They illustrate the effect of poor care of the wells on the purity of the water. Often this poor care is due to lack of sanitary knowledge. Conditions similar to these exist in many of the Piedmont villages.

TABLE NO. 9.

The Watkinsville Community.

Specimen number	39	40	41	42	43	44
Sanitary score %	35	35	50	75	40	55
Free ammonia	.020	.015	.040	.000	.000	.000
Album. ammonia	.075	.110	1.200	.025	.000	.000
Nitrites	.0050	.0150	.0040	.0020	.0000	.0000
Nitrates	.800	.900	.600	.400	.250	.180
Chlorine	4.0	45.5	10.5	6.0	3.0	3.5
Oxygen required	.100	.140	.030	.000	.210	.010
Total solids	91	416	180	105	74	150
Loss on ignition	46	220	82	50	37	128
% Discoloration	45	25	25	25	40	30
Hardness	32.3	46.2	39.5	32.7	8.5	11.0
Turbidity	20	40	30	10	5	5
Bact. exam	3	5	5	4	5	1
Analyst's opinion	—	—	—	—	—	—

From the chemical examination, the first well appears to have received large amounts of organic matter a short time before the specimen was taken as is indicated by low ammonias and high nitrites and nitrates. The vegetable nature of the organic matter is indicated by the low chlorine content. The second well apparently had received large quantities of contaminating material of animal nature as indicated by the high chlorine content. The third is similar to the first. The last two wells would have been classed as safe from a chemical examination alone and the fourth one as safe or questionable. All of the wells in this table, however, failed to pass the bacteriological test. The gas forming organisms must have been taken into these last two or three wells from the hands of some one drawing water as it does not seem likely that contaminating matter of either vegetable or animal nature in appreciable quantities is getting into these wells.

The Augusta Community.

In several sections of the Coastal Plains the sandy type of soil permits the use of a driven type of well. The construction of these wells is very simple. A two inch pipe is driven thirty or forty feet into the ground. The soil is removed from the pipe by means of an auger or by pumping water into and out of the well. We were able to study this type of shallow well in a negro community in the suburbs of Augusta.

The community studied in Augusta is situated between the Milledgeville road on the northwest and the Savannah road on the southeast. It is known locally as Turpin Hill.

This community appeared more progressive than any of the others which we studied. The houses were not crowded. Most of them were painted. The premises were clean and generally well kept. Inquiry brought out the fact that most of the negroes were living in houses which they owned. The negroes were more courteous in this community than in the others in which we studied. They did not manifest the usual suspicion about our work.

The soil in this community is of the sandy loam type. The water level in average weather is about ten to twelve feet. The upper layer of soil was underlain apparently by soil of a different type. One of the impure wells in this community was a drilled well seventy-two feet deep.

Nine of the twelve wells studied in this community were of the driven type. They were fitted with small pitcher pumps to bring the water to the surface. The pumps were the most unsanitary part of the wells. Such pumps do not hold the water in their cylinders when the pistons begin to wear and water has to be poured into the cylinder in order to cause the piston to commence functioning. At most of the wells an old fruit jar or lard pail was left full of water each time that water was pumped to "cup" the pump when it should be used again. These containers are left on the ground beside the pump. Dust falls into them, chickens drink out of them, birds bathe in them, flies and insects drown in them, and small children play in them; but, no attention is paid to such happenings. They are taken as a matter of course. As long as the water is clear, the person using the pump appears to care nothing about its purity when he pours it into the pump. Where the pumps are on the back porch, water is secured from the water bucket to wet the piston and the risk of contaminating the water is not as great as when the pump is located in the yard. The contamination taken into the water supply by such means would be of bacterial nature and would not be detected by a chemical examination. We were unable to make a bacteriological examination while we were studying the wells in this community because of remoteness from laboratories.

This community is another example of suburban communities using shallow wells as a source of their water supply. As this type of well can be used only within a limited range of physical conditions, we believe the data secured on this type of well to indicate approximately the conditions of these wells of which there are several thousands in use in the Coastal Plains region where the soil conditions permit. The condition of the wells in this community may be gathered from the following tables of data.

TABLE NO. 10.

The Augusta Community

Specimen number	45	46	47	48	49	50
Sanitary score %	80	80	80	70	75	75
Free ammonia	.050	.180	.000	.000	.000	.000
Album. ammonia	.000	.150	.000	.000	000	.200
Nitrites	.0000	.0030	.0010	.0000	.0005	.0003
Nitrates	.150	.110	.160	.120	.120	.250
Chlorine	5.0	10.0	11.8	12.9	11.2	13.7
Oxygen required	.875	.750	.850	.800	.750	.800
Total solids	23	72	36	70	39	43
Loss on ignition	5	21	26	7	26	27
% Discoloration	25	70	50	35	35	35
Hardness	25.7	36.8	22.1	23.5	26.5	22.0
Turbidity	10	100	20	15	10	10
Analyst's opinion	+	—	+	+	+	—

TABLE NO. 11.

The Augusta Community, Continued

Specimen number	51	52	53	54	55	56
Sanitary score %	50	50	65	75	70	75
Free ammonia	.025	.015	.010	.000	.000	.000
Album. ammonia	.100	.060	.060	.080	.000	.010
Nitrites	.0000	.0100	.0002	.0000	.0005	.0008
Nitrates	.050	.400	.350	.100	.050	.020
Chlorine	15.5	12.5	16.5	27.0	19.8	18.1
Oxygen required	2.300	2.025	.950	.800	.900	.900
Total solids	50	116	49	43	45	25
Loss on ignition	33	37	24	20	26	10
% Discoloration	60	70	50	50	35	45
Hardness	29.4	29.4	50.0	58.8	38.2	52.9
Turbidity	60	50	30	25	10	15
Analyst's opinion	?	—	+	+	+	+

Specimen No. 46 was a drilled well 72 feet in depth. It appears to be receiving contamination of a vegetable nature probably through an underground stream, as there is little probability of surface water getting into a well of this type.

Specimens No. 51 and 52 were taken from shallow dug wells. They seem to be receiving contamination of vegetable nature since the oxygen requirement is high in both of them.

The great uniformity of the tests for the forms of nitrogen is one of the striking features of the remaining nine wells of the driven type. All of these wells have a high chlorine content. In cases like these the chlorine content does not have very great significance unless it is accompanied by appreciable amounts of the ammonias and nitrates, by a very large oxygen requirement, or by considerable loss on ignition with a high per cent of discoloration. There must be other evidences of contamination than the chlorine alone, for the chlorine in the water is usually residual. To illustrate, the iron casing of such wells prevents surface water from running into them. In order to get into the well the water must percolate through thirty or forty feet of sandy soil. While doing so, most of the organic nitrogen compounds are probably oxidized to nitrates and in this state are probably used by plants. The chlorine remains, as it is not used by plants to any great extent and is carried into the well by the water. All of the disease germs should be retained by the sandy soil while the water is passing through. It is evident, therefore, that a slightly high chlorine content should not cause a well to be condemned, because the water is undergoing natural filtration which probably removes the bacteria but does not remove chlorine.

THE DUDLEY COMMUNITY.

Dudley is one of the villages of Laurens County. It is located about eleven miles from Dublin on the Macon and Dublin highway. The population of Dudley is approximately two hundred and fifty. Of this number about thirty per cent are negroes. Most of the negroes work at a large planing mill operating at Dudley. The white people are merchants or farmers.

This village is situated on a hill and has excellent drainage.

The soil is a type of clay loam. The water level is about twelve feet below the surface of the ground in average weather. In rainy weather it may rise to within one or two feet of the surface. One of the wells from which specimens were taken is said to overflow in wet seasons. (See Plate 26).

The houses are built on lots of an acre or more and are of fairly good construction. The premises are kept in good shape so far as the purity of the water supplies are concerned.

The type of well used in this village is similar to the kind that is used over most of the Coastal Plains. Shallow wells varying from fifteen to fifty feet in depth are dug in the soil. Generally they are never more than four feet square. The opening at the surface does not have to be large, as little, if any, rock will have to be removed. Many of them are not more than three feet square at the surface. Most of them do not have curbs. Where curbs are necessary, either boards or terra cotta pipe are used. These wells are not covered by a platform of boards as in the Piedmont region. A square box open at both ends is inserted over the well and dirt is piled against the lower boards to prevent surface water from running in and to hold the box in place. No means of covering the well is provided at all. For the type of well box used in the Coastal

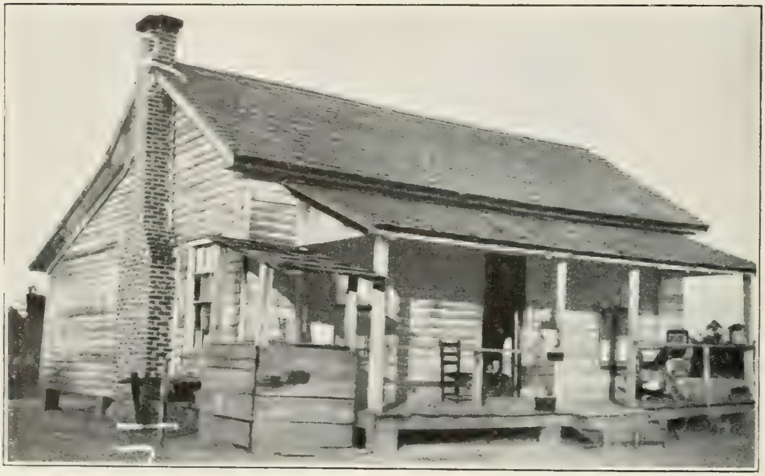

PLATE 24. *Typical Coastal Plain wells. The type of well box deserves particular notice. For others see Plates 24A and 24B.*

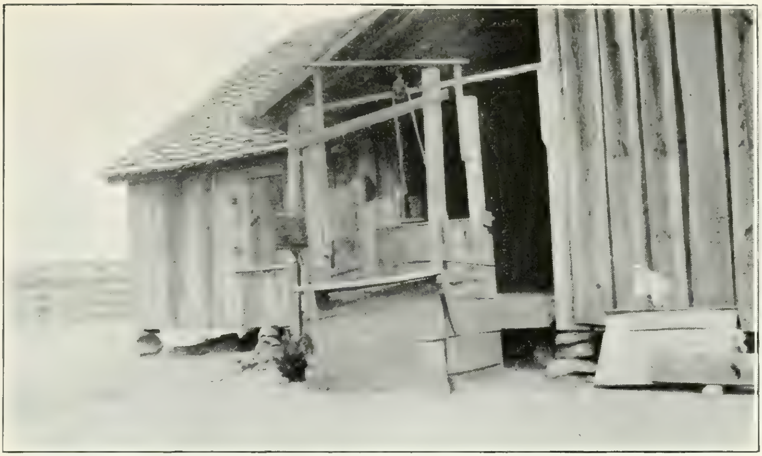

Plate 24A.

Plate 24B.

Plains, see Plates 24, 24A, 24B, 25, and 26. While there is no danger of water running back into the well from a leaking platform, dust and flies have easy access to these wells.

PLATE 25. *Twelve negro families use water from this well. Specimen No. 59 was taken from it.*

PLATE 26. *This well is situated in a bottom at Dudley and is said to overflow in wet seasons. Specimen No. 58 was taken from it.*

The condition of the shallow wells in Dudley indicates what might be expected in several hundred such villages in the Coastal Plains region. The data about the wells in Dudley are presented in the following table. It is especially applicable to villages in the upper half of this region.

TABLE NO. 12.

The Dudley Community.

Specimen number	57	58	59	60	61	62
Sanitary score %	65	40	35	50	60	65
Free ammonia	.000	.050	.000	.000	.020	.050
Album. ammonia	.025	.125	.050	.000	.075	.050
Nitrites	.0000	.0025	.0030	.0000	.0000	.0000
Nitrates	.120	.300	.250	.180	.030	.080
Chlorine	15.5	19.4	6.3	10.6	13.3	15.5
Oxygen required	.975	.830	.395	1.260	.420	.975
Total solids	45	85	137	31	125	116
Loss on ignition	27	25	70	26	35	63
% Discoloration	45	25	50	50	60	35
Hardness	15.7	6.4	11.0	7.8	7.1	10.5
Turbidity	100	50	500	5	140	70
Bact. exam		2	3	1		
Analyst's opinion	+	—	—	?	+	?

THE RURAL COMMUNITY NEAR DUDLEY.

In the Coastal Plains region the conditions affecting the rural water supplies where shallow wells are used are very similar to those of the Piedmont region. The uniformity is especially noticeable. Because of this we did not think that it best to get data about a number of rural wells located near one another. We selected six wells which we thought would indicate the conditions existing around Dudley. The distance that these wells are located from Dudley varies from one to seven miles.

These wells were being used by negro farmers who rented the land which they were farming. Most of the negroes engaged in farming near Dudley are of this class. Mules, hogs, cows, chickens, etc., are kept on the premises of these farmers. The danger of polluting the water is accordingly increased. See Plates 27 and 28.

The well type and soil conditions are similar to those already described for Dudley; see Plate 27 for a typical rural well.

These wells indicate the condition of the water supply on many of the small farms owned or rented by negroes in the

Coastal Plains region. The number of such farms is large in this region.

Plate 27. *A typical rural well of the Coastal Plains.*

The following table, No. 13, contains the data gathered in the rural community near Dudley.

TABLE NO. 13.

The Rural Community Near Dudley.

Specimen number	63	64	65	66	67	68
Sanitary score %	50	50	60	30	40	65
Free ammonia	.100	.075	.125	.025	.000	.010
Album. ammonia	.060	.100	.000	.090	.060	.080
Nitrites	.0120	.0000	.0030	.0250	.0000	.0000
Nitrates	.600	.750	1.400	.750	.000	.300
Chlorine	60.5	29.6	34.5	46.2	17.2	18.2
Oxygen required	.375	.175	.325	.530	.730	.200
Total solids	173	150	138	190	73	84
Loss on ignition	36	67	16	58	33	52
% Discoloration	30	30	25	25	35	30
Hardness	13.5	28.7	24.3	22.8	1.9	15.9
Turbidity	15	10	250	45	5	60
Analyst's opinion	—	—	—	—	?	?

There were no new conditions of contamination revealed by the studies in and around Dudley. The condition of the contamination in each of these wells is similar to the condition of a Piedmont Plateau well already discussed.

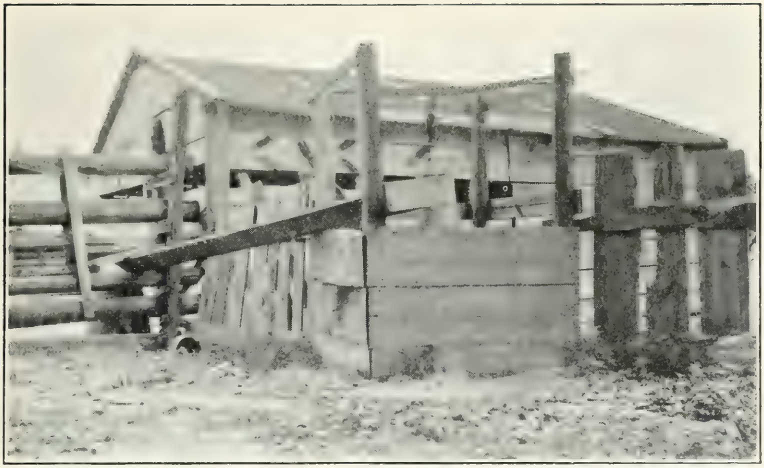

Plate 28. *A Coastal Plains well dug between the barnyard and the hog pasture.*

Wells of Special Interest.

The first analysis in Table 14 is of a specimen taken from a public well situated on a public square in the village of Dexter, Laurens County, Georgia. Many of the villages of the Coastal Plains have these public wells. See Plate 29. They

Plate 29. *A public well in a Coastal Plains village.*

are used to a considerable extent by negroes on Saturday afternoon excursions to the villages. Such wells are seldom sanitary because a few thoughtless or mischievous individuals make a practice of throwing trash into them. In the Coastal Plains these wells are not sufficiently protected against flies and other insects, and dust.

The second specimen in this table was taken from the Oconee Cemetery well

The third specimen was taken from a well in the suburbs of Dublin being used by seven negro families. The color of this water was a deep yellow, or orange. This water contained much organic matter as indicated by the high albuminoid ammonia and the high oxygen requirement. The chlorine content seems to indicate that some animal contamination was getting into it also.

The fourth specimen in this table was taken from the well being used by the Dudley High School. About one hundred and seventy-five children drank water from this well during the school year. The analysis indicates that the water is very impure. From the unsanitary condition of the platform over the well we could expect nothing else. The condition of the platform may be judged from Plate 30.

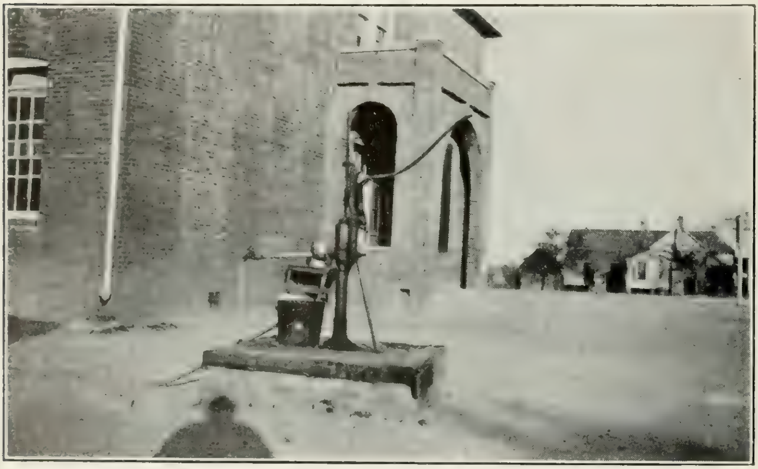

PLATE 30. *The Dudley High School well.*

Such platforms as these seem to be generally used where pumps are installed in Coastal Plains shallow wells. In our estimation the open well with rope and bucket would be more sanitary than pumps installed in such a manner. Properly installed pumps are many times safer than the open wells, however.

Notice the high chlorine content of the fifth specimen. Salt (sodium chloride) had been added to this well a few days before the specimen was taken to kill "wiggle tails," or mosquito larvae.

The last specimen in this table was taken from a well in Madison County, at the special request of a negro farmer. He said that he had been living at this place for four months. There had been seven cases of typhoid fever in his family since he had moved there. Two of those who had fever died. As may be seen from the analysis, this well was receiving contamination of animal excreta and had colon bacilli in every ten milliliters of the water. We confirmed the presence of colon bacilli in this water and made slides of the organisms.

PLATE 31. *The typhoid well.*

These slides resembled very closely the specimen of slides of typhoid bacilli.

The sanitary conditions of the premises may be judged from the accompanying picture, Plate 31. The well had caved under the concrete platform on the northeast corner until water could enter the well from the barnyard by passing through two feet of soil.

There were many feathers scattered around the washpot. It seems that the negro mother had imperfectly burned within a dozen feet of the well the bedding on which her daughter had died of typhoid fever the week before.

TABLE NO. 14.

Wells of Special Interest.

Specimen number	69	70	71	72	73	74
Sanitary score %	60	70	30	40	60	20
Free ammonia	.010	.085	.075	.050	.100	.040
Album. ammonia	.040	.305	.550	.150	.050	.150
Nitrites	.0000	.0000	.0010	.0050	.0080	.0090
Nitrates	.025	.110	.100	.140	.550	3.600
Chlorine	12.5	6.5	49.6	75.8	112.0	40.8
Oxygen required	.560	.430	2.330	.240	.215	.160
Total solids	48	65	480	237	302	76
Loss on ignition	30	11	121	67	37	29
% Discoloration	30	35	80	35	40	30
Hardness	8.6	36.7	25.7	13.2	9.1	11.6
Turbidity	10	20	600	10	30	10
Bact. exam			4	2		5
Analyst's opinion	?	?	—	–	—	—

SUMMARY OF DATA.

From the analyses made, we find that out of the seventeen rural wells studied, five, or 29.4 per cent were judged safe; five, or 29.4 per cent were placed in the questionable class; and seven, or 41.2 per cent were considered unsafe.

Of the twenty-one village wells studied, six, or 28.6 per cent were safe; two, or 9.5 per cent were of questionable purity; and thirteen, or 61.9 per cent were classed as unsafe.

Excluding the driven wells, of the twenty surburban shallow wells studied, three or 15.0 per cent were judged safe; three, or 15.0 per cent, were placed in the questionable class; and fourteen or 70.0 per cent, were considered unsafe.

Of the driven wells in the Augusta community only one of the nine wells studied was considered to be receiving contaminating material in quantities sufficient to condemn it. From the chemical examination the other eight wells were considered safe. It should be kept in mind that no bacteriological examination was made of these wells to check on the high chlorine content of some of them. Such examinations should be made before they are classed as absolutely safe. From the chemical examination alone, they appear to be much better than the shallow dug wells.

While most of the bacteriological examinations were made of wells which would have been condemned because the chemical tests indicated that contaminating matter was reaching them, the fact that several of the wells which would have passed the chemical examination with a clean record were found to be infected with bacteria is significant. This indicates that some of the wells were receiving bacteria through the top, probably from dust. Had we been able to make a bacteriological examination of all the wells studied, we think that many wells classed as questionable and some classed as safe would have been condemned.

All degrees of purity and impurity are represented in the wells studied. The degree depended on local conditions. In general most of the wells classed as pure were only slightly better than the best wells in the questionable class. Also, most of the impure wells were but little worse than the poorest in the questionable class. No one should drink questionable water however.

The sanitary conditions in relation to the negro's water supply is generally better in the rural communities than in the villages and somewhat better in the villages than in the suburban communities.

In cities where there is a water system in operation the mains and sewers are generally only partially extended to the negro communities. Extension of the city water system to the negro communities is generally neglected or ignored. As a consequence of the failure to get water from the city system many negroes are compelled to use shallow wells or to carry the city water inconvenient distances. The shallow wells located on the outskirts of cities are usually unsanitary unless exceptionally good physical conditions operate to help keep them sanitary.

While there is partial extension of the city water system to negro communities in cities of several thousand population, in the small cities with a population of two or three thousand practically none of the negroes have access to the city water system.

From a few surveys which we made and our general observation we believe that over ninety per cent of the negroes living in the Piedmont and Coastal Plains regions are using shallow wells as a source of their water supply. Most of the shallow wells are dug wells.

In gathering data for this thesis only one analysis or one sanitary survey was made of a given water supply. This would not be sufficient to guarantee the absolute purity of a water supply for drinking purposes. It is sufficient to indicate the health conditions as revealed by the water supply. Even if the same wells were reexamined after a few months, the ratios of good wells to poor wells would be approximately the same although the results of the analysis of individual wells probably would not be the same.

CHAPTER III

SOCIOLOGICAL IMPLICATIONS.

From the point of view of the social technologist the problem presents two aspects or is localized into two rather distinct fields, the rural and the urban. In each of these fields, in turn, there are two phases of the problem; the one the general community problem of how to secure and maintain an adequate water supply and the other that of the racial problem that already exists, or that may arise in the process of arriving at an adequate water supply.

To people who do not understand how diseases originate and spread, a water which is clear and cool is pure. This is the only criterion which they are able to apply to their drinking water.

As they do not understand what constitutes a pure water supply, the negroes are not in a position to provide a pure water supply. They locate their wells improperly, use the wrong method of getting water to the surface, and take little care of the wells in general. The average negro thinks that he is taking excellent care of his well when he cleans it out every two or three years. He does not understand that he should not build a privy within a few feet of the well or that he should take effective steps to prevent surface water getting into the well. He may be told that his privy is endangering his water supply. He will probably take it up and move it to the back corner of the lot and build a pig pen on the old privy site, because he did not understand why the privy was dangerous to the water supply in the first place. He may spend considerable money putting in a concrete cover over his well to keep the surface water out and then dig a flower pit or a privy by the side of the concrete cover. The pit will probably be as deep as the depth of the concrete cover. Many negroes use their wells as refrigerators. Fish, beef, milk, and other articles of food are let down into the well in the water bucket to keep cool.

The negro community at Watkinsville appeared to be the worst community which we studied in so far as sanitary practice was concerned. One of the negro families used the platform over the well as a wash bench. Enough of the blueing water had leaked into the well to give the water a distinctly bluish tinge. The condition in this community may be due to the fact that the more progressive negroes have migrated to larger cities. The migration from this locality has been large. The cause of this migration would be an interesting subject for future study.

Whether there is an exploitation of the negroes from which they were seeking escape by migrating or whether the economic situation in that section was responsible for the unsanitary conditions and also for the migration would be an interesting sociological problem to be investigated.

We do not think that the status of the negro educational facilities as compared with the facilities of white people has very much to do with the general lack of sanitary knowledge. The problem of sanitary education is more of a community problem. Improvement in the school systems will reach only a part of the problem. The methods followed at the present time in teaching sanitary knowledge in schools fails to reach the problem of a pure water supply in most instances. A method should be worked out that will bring the problem of impure water home to the child. The adult should be instructed also if we are to make much progress in improving the sanitary condition of the water supplies through increasing the amount of sanitary information posessed by people using the water.

Although our actual analytical work dealt principally with negro water supplies, all the information which the sanitary surveys revealed and all the information which we gathered from the work of others suggested strongly that the shallow wells being used by white people were no purer than the wells used by negroes. This inference is borne out by the studies of rural wells made by the Department of Agriculture. These studies were concerned almost entirely with white peoples' wells. They indicated that we should find about twenty-five per cent of rural wells safe. Our results showed a slightly higher per cent (29.4%) of safe negro wells in the rural districts. It is apparent, therefore, that the problem of impure shallow well water supplies is not racial.

In this connection it is interesting to consider the wells used by tenants in the rural districts. One year a well may be used by a negro tenant and the next year by a white tenant. White people and negroes frequently use the same well as a source of supply. While at work, negroes and white people usually drink water from the same well.

MEETING THE PROBLEM OF WATER POLLUTION.

The first step in meeting this problem is to disseminate information about the situation. This can be done by bulletins, posters, through schools, and by the health officers. Data such as obtained in this study will be very valuable in showing how widespread and how important this problem is.

Posters are very effective in attracting the attention and holding the interest of people whom it is desired to influence. They should not be exaggerated. They should represent the actual conditions as nearly as possible.

Personal workers are more effective than bulletins or posters. This is especially true for many negroes and some white people, as they do not have sufficient education to appreciate fully the message of posters or bulletins. The Health Officer, the County Agent, the Home Demonstration Agent, the Superintendent of Schools, the vocational teachers, and other teachers may be secured as temporary personal workers.

The second step is to teach some sanitary principles to well owners. The campaign for better water supplies will be unsuccessful unless the well owners are made to understand the reasons why they should purify the water supply and the sanitary principles involved in purifying it. This applies equally to white people and negroes.

Some information should be furnished as to the probable cost of the water purification. The first problem is to make the well owner see that he can financially afford to put his well in first class condition. He should be made to see that an unsafe well is a financial liability because of the diseases it may cause.

The third step is to set an objective for each particular community. The county health officer, the county demonstration agents and the vocational teachers can be of much assistance.

The campaign should be thoroughly planned so as to reach each well owner before it is begun. Efforts should be made to have a personal worker make one or two visits to each well owner. It will add much to the chance of success if the worker can induce the well owner to have an analysis made of a specimen of his water. Those who have pure water will usually take great pride in keeping it pure while the importance of a pure well can be presented in no other manner so effectively as by showing a well owner that his well is actually impure.

The ultimate objective for the village and the rural districts should be a drilled well of some kind. In the Piedmont and the Coastal Plains the drilled well has to have an iron casing. The soil is of such type as to prevent rapid seepage. The casing of this type of well makes it necessary to use a pump to get water out of the well. With the top of the casing closed by a pump, surface water excluded by the casing, and

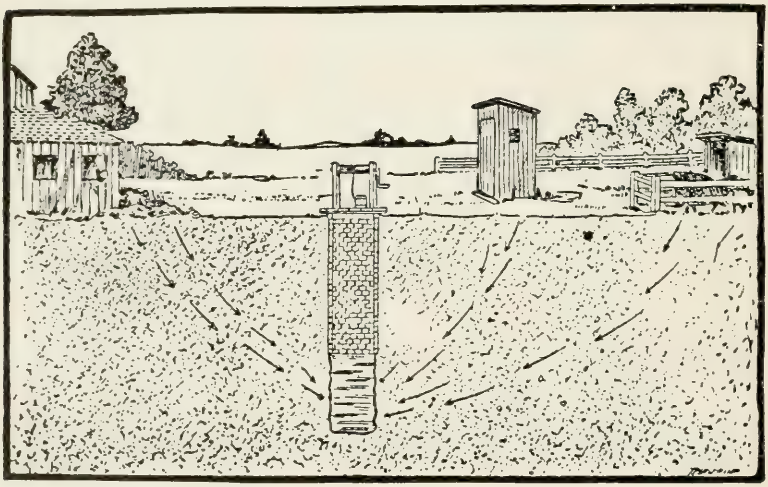

PLATE 32.

A DANGEROUS WELL

ALL OPEN OR BUCKET WELLS ARE DANGEROUS.

It is evident from the picture that the well is not only subject to filth from the open to, but is also made dangerous by surface drainage from the toilet, barn, etc.

(Subscript by Dr. B. B. Bagby of the Athens Board of Health)
(Cut loaned by Virginia State Board of Health)

the water which enters at the lower end of the casing being filtered as it slowly percolates through the soil, this type of well is nearly ideal in a sanitary way. It is best to drill three hundred feet or deeper. The minimum safe depth varies with each particular locality and is best determined by a local sanitary engineer.

In the majority of communities it will be impractical to attempt a campaign for the drilled type of well now, because of the expense. The objective in these communities should be to ged rid of the open type of well and of the well covered by a wooden platform. These wells are always unsanitary. See Plate 32 in this connection. In a few communities the driven type of well may replace the dug well. We believe this type of well to be more sanitary than the ordinary dug well. The depth to drive these wells and other details will depend on local conditions. In most communities, the only practical immediate objective is an impervious concrete cover. These covers are not very expensive and if properly constructed, will prove effective. They should be constructed in such a way as to prevent water spilt on them from getting into the well. The concrete should be four or five feet in the ground in order to prevent surface water from running directly into the well. See Plate 33. The greatest care should be taken in constructing these covers to make them water proof. Wrong proportions or careless mixing of the concrete will render the concrete pervious and therefore unsafe. In some instances new wells will have to be dug because the well was improperly located when it was dug.

Safe privies should be a part of the general campaign for better water supplies. It is from improperly located privies that most of the harmful contamination reaches a water supply. The type used is not important to the purity of the water supply if the privy is located so as not to be a source of pollution.

The fourth step is to get people to act on the information furnished and the sanitary principles taught. Most everybody believes that a pure water supply is desirable. Many people, however, are so indifferent that they will not throw a few shovelfuls of dirt in a ditch to prevent surface water from running directly into the well. This indifference will be felt when

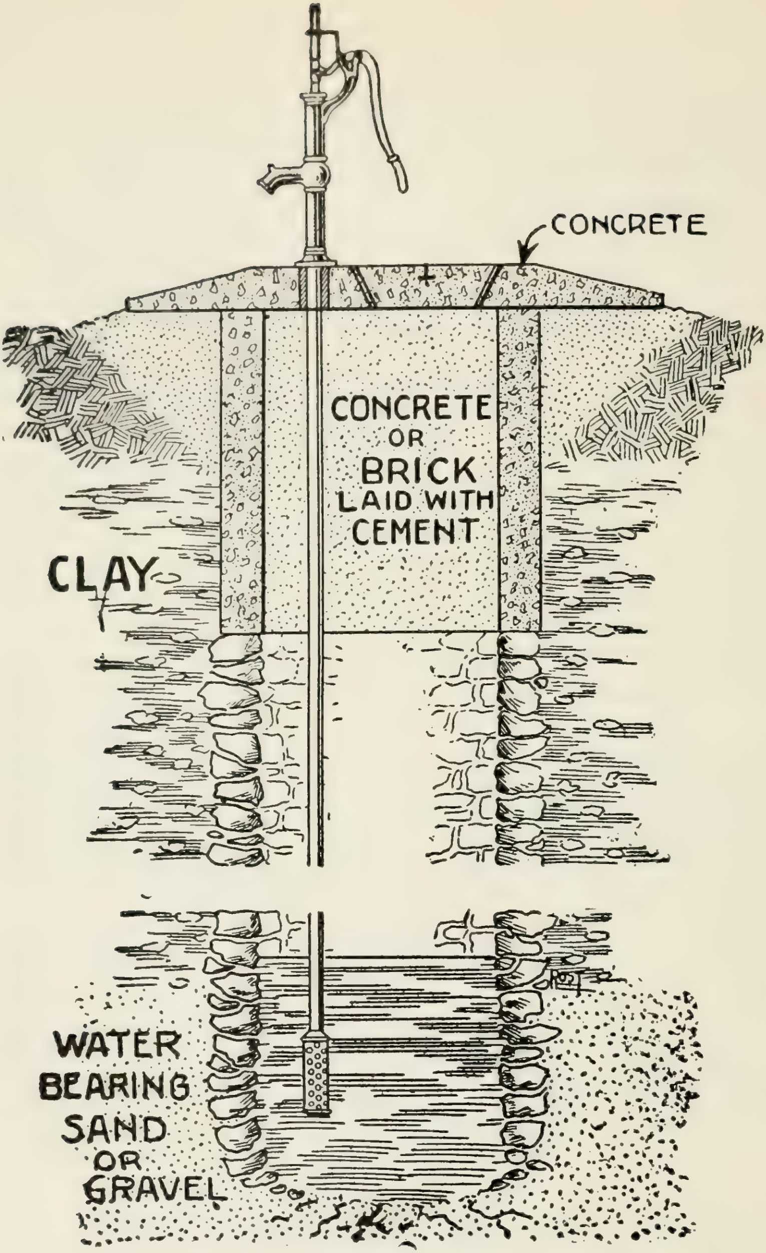
CONCRETE
CONCRETE OR BRICK LAID WITH CEMENT
CLAY
WATER BEARING SAND OR GRAVEL

PLATE 33.

A SAFE WELL

A safe well must be so located that it is away from the drainage of the toilet, stable, and home; and also, it must be provided with a pump on a concrete base which extends at least two feet over the sides, well into the ground to prevent surface pollution.

an attempt is made to get them to act on their particular problem of an unsanitary well.

It is usually possible to find some public spirited citizen who is willing to take the lead in this work. By using such a man as an example, the problem can be made personal to other individuals and much good accomplished. Once it becomes fashionable to safeguard the water supply, little trouble will be experienced in getting people to do it. A public spirited citizen who is actually putting his well in first class condition will be of immense value in making well improvement fashionable.

Each individual should be furnished detailed information applicable to his particular problem before he begins to work. If this is not done much effort and money may be wasted. Where possible, a personal inspection of the premises should be made by a sanitary expert before work is begun. With the majority of negroes and many white people, this is the only method that promises much success.

Much valuable information about sanitation is available in bulletins of the U. S. Public Health Service and of the various State Boards of Health. Information about well engineering, plumbing, concrete work, and similar matters is available in bulletins of the Department of Agriculture and the publications of the various State Colleges of Agriculture.

The problem of an adequate water supply, however, must become more than an individual problem, it must become a community problem. It is not sufficient that a particular farmer or head of a household should be concerned with securing an adequate water supply for his own family. He must be concerned with securing an adequate water supply for his neighbor as well. It is at this stage in its development, the stage in which the leaders in the community arrive at the decision that the entire community ought to and must have an adequate water supply that it becomes a social problem. It is at this same stage in its development that the problem may also become a racial problem.

In the urban districts the problem of an adequate water supply has already become a social problem. The racial aspects of this problem will be discussed under the urban aspects of the problem.

The results of our analyses indicate that shallow wells located in the suburban communities are generally impure. Even the wells found to be pure are potentially impure because of the density of the population and the sanitary conditions which are usually poor. In contrast to the general unsafe condition of shallow well water supplies, the city water supply is comparatively safe. The purity of the city water is due to the careful treatment given the water to remove harmful matter. Frequent tests are made to see that the treatment given the water is effective in keeping it pure.

In spite of the comparatively good condition of the city water and the poor condition of shallow wells, we find practically all the negroes and many white people using shallow wells in Georgia cities whose population are below five thousand. In larger cities this condition is somewhat better. Practically all the white people and many of the negroes in the larger municipalities use city water.

It is a fact that cities in the territory in which we studied tended to neglect the extension of sewers and mains into the negro communities. They are seldom laid in the negro communities except when they incidentally pass through the negro community to reach a white community. Such neglect of the water supply of the city negro may appear deliberate on the part of the city water board. Careful analysis of the situation shows that in part as least, such conditions arise from the economic status of the negro. In the first place, most cities go in debt to install their water systems. Consequently, they do not extend the mains farther than the business sections and the most densely populated part of the white communities. Seldom do all of the white people get water connections at first. It would cost more money than is usually available to extend the system to the negro houses which are usually built on the outskirts of the city. It is very probable that negroes use less water than the same number of white people. Therefore, the small city finds itself unable to extend its mains to the negro communities for financial reasons. The negroes are unable to bring the water to their houses for the same reason. Many white families living beyond the limits of the city mains will frequently lay a private pipe line to the city mains and install a private sewer system.

As the city grows the mains and sewers are extended to the old negro communities. But in the meantime new negro communities have grown up farther out. Frequently they are beyong the limits of the city proper. White communities are usually built by development companies who install the mains and sewers at their own expense intending to reimburse themselves when the property is sold. Negro communities grow up, they are seldom planned in advance. As a result, the city water board fails to furnish water to them because of the cost which they are usually unable to meet and which the board is not able to meet either.

It may appear that the small proportion of negro voters is responsible for the neglect of the water boards to extend water mains and sewers to the negro communities. In some instances this may be true, but in most cases, we believe that it is due to the low economic level and civic standard of the city negro as compared with the city white man.

It appears to us that the use of the shallow wells by suburban negroes is due to economic reasons and to a lack of sanitary knowledge as outlined above. If this is true, the problem is not racial except in so far as prejudices or unfair discriminations have operated to keep the negro at a low economic and educational level. These things would have to be investigated by methods other than those used in this study.

Of course it is possible that the low percentage of negro voters in proportion to the negro population and many other reasons, may be particularly responsible for the negro being forced to use shallow wells. This would be an interesting subject for further study, but it would have to be investigated in a manner different from the one used in this study. Whatever may be the causes, direct or indirect, indifference on the part of the entire city population must be overcome before any real progress can be made.

To bring our city population out of this indifference in regard to the use of shallow wells by part of the people and to teach them more of the principles of sanitation is distinctly a community problem[10] as it is an important part of the general health problem of the community. It has been frequently demonstrated that disease germs are unacquainted with color lines, and municipal, or other geographical boundaries. This fact was strikingly illustrated by the recent world wide epidemic of influenza which was thought to have originated among Chinese prisoners in a German prison camp. Today, the contacts between the white people and the negroes in cities are so numerous that neither race can suffer from disease without endangering the health of the other race.

---

[10] Community is used here to mean all the individuals and groups in the city and its suburbs.

In a large measure this problem will have to be met by community education of the adults. It must be solved by the adults of today if we are to escape great suffering and losses resulting from the use of impure water. Our school systems may be effectively teaching the principles of sanitation to the children, but the knowledge gained by children in school will be felt only after the children have grown up and shouldered the responsibilities of the older generations. Frequently, those who have considerable academic training in sanitation require experienced guidance before than can fully apply their knowledge to a problem such as securing pure water for everybody in the community.

The method of meeting the cost of such a program can be best worked out by each individual city. In some, the mains and sewers can be installed and the owners of the houses allowed to gradually reimburse the city. In others it can best be done by issuing bonds that mature at distant periods in the future when the city will probably be in a better position to meet the expense. In a few, the work can be paid for directly out of the public taxes.

After the city has extended its water system to all of the houses in the city, all of the shallow wells should be filled up to prevent their being used as a source of drinking water. No new well should be allowed to be dug in the municipal limits and care should be taken to extend water connections to new houses built beyond the municipal limits but in the city proper. If these things are done the cities will have little to fear from impure water.

It should be kept in mind that the most expensive part of extending a water system is usually the extension of the sewer system. While a sewer system is very desirable, it is not absolutely necessary. Sanitary surface toilets are fairly satisfactory where there is no danger of the water supply being contaminated by them. How effectively epidemics of water borne diseases can be checked by pure drinking water is illustrated by the section of Athens East of the Oconee River. (loc. cit.) By emphasizing the value of pure drinking water regardless of the desirability of sewers, some of the more progressive people living in the suburban districts might be induced to lay pipe lines at their own expense.

From this study it is quite obvious that the problem of an adequate water supply to the negro in the urban districts has passed beyond the stage of an individual health problem and is becoming a community health problem. It is equally obvious that it is primarily among the white leaders of the urban districts that this is becoming a social problem, i. e., it is primarily within the control of the whites to provide the facilities for an adequate water supply.

Also, it is to them that we must look for the development of a social conscience. If in arriving at this new social conscience the community leaders arrive at a conception of this as an essential to good health rather than as a luxury it is not at all probable that it will become a racial problem. A typhoid contaminated well, an open privy, and numerous places for breeding flies on a negro's lot are just as dangerous to public health as are similar conditions on a white mans' premises. It is in the community in which these sanitary measures are arrived at as individual luxuries rather than as social necessities health as are similar conditions on a what man's premises. It possessing sanitary premises has its chief value in the social prestige it adds to the possessor, then we may look for it to lead to racial and other class discriminations; if its chief value lies in the protection it offers to public health it is practically certain no racial discrimination will be made. In short, in this as in a great many other problems the solution of the problem of race relations is to be found outside the race problem as such and in the problem of correct social evaluations along other lines.

TECHNICAL REFERENCES.

U. S. DEPARTMENT OF AGRICULTURE:

Bulletin 57, p. 2.
Farmers' Bulletin 1448.
BUREAU OF PLANT INDUSTRY. *Bulletin* 154, p. 83.
DIVISION OF AGRICULTURAL SOILS *Bulletin* 4.

GREAVES, J. E. *Elementary Bacteriology.* Phila. Saunders. 1928.

JORDAN, E. O. *Textbook of General Bacteriology.* Saunders. 8th rev. ed. 1924.

MAHIN, E. G. *Quantitative Analysis.* N. Y. McGraw-Hill. 1924.

MASON. *Examination of Water, Chemical and Bacteriological.* N. Y. Wiley. 5th rev. ed. 1917.

OLSEN, J. C. *Quantitative Chemical Analysis.* N. Y. Van Nostrand. 5th ed. 1916.

ROSENEAU, M. J. *Preventive Medicine and Hygiene.* N. Y. Appleton. 5th ed. 1927.

STITT. E. R. *Practical Bacteriology, Blood Work and Animal Parasitology, etc.* Phila. Blakiston. 7th rev. ed. 1923.

TANNER. F. W. *Bacteriology and Mycology of Foods.* N. Y. Wiley. 1919.

THRESH, J. C. *Examination of Water and Water Supplies.* Phila. Blakiston. 3rd ed. 1925.

TREADWELL, F. P. and HALL, W. T. *Analytical Chemistry.* N. Y. Wiley. Vol. I, 5th ed., 1919; Vol. II, 6th ed., 1924.

WANKLYN, J. A. *Water Analysis.* London. Kegan Paul. 11th ed. 1907.

SOCIOLOGICAL REFERENCES.

(Only those references that were used extensively in the study of race relations as part of this study are listed below. For a well balanced bibliography of the subject the reader is referred to Weatherford, W. D., *The Negro from Africa to America.* Doran. 1924. ATLANTA UNIVERSITY PUBLICATIONS. Atlanta University Press).

No. 1. *Mortality Among Negroes in Cities.* 1896. Same, 2nd ed. abridged. 1903.
No. 2. *Social and Physical Conditions of Negroes in Cities.* 1897.
No. 11. *Health and Physique of the Negro American.* 1906.

CHICAGO COMMISSION ON RACE RELATIONS. *The Negro in Chicago.* University of Chicago Press. 1922.

KERLIN, R. T. *The Voice of the Negro.* N. Y. Dutton. 1919.

MILLER, KELLY. *Race Adjustment.* N. Y. The Neale Publishing Co. 1908.

STEPHENSON, G. T. *Race Distinctions in American Law.* N. Y. Appleton. 1910.

WEATHERFORD. W. D. *Negro Life in the South.* N. Y. Association Press. 1911.

WEATHERFORD, W. D. *The Negro From Africa to America.* N. Y. Doran. 1924.

PHELPS-STOKES FELLOWSHIP STUDIES

1. Woofter, Thomas J. Jr. *Negroes of Athens, Georgia.* 1913. 62 p. illus. map. 40 cents.

2. Hill, Walter B. *Rural Survey of Clarke County, Georgia, with Special Reference to the Negroes.* 1915. 63 p. illus. maps. 40 cents.

3. Johnson, Miley K. *School Conditions in Clarke County, Georgia, with Special Reference to the Negroes.* 1916. 50 p. illus. maps. 35 cents.

4. O'Kelley, Hoke S. *Sanitary Conditions Among the Negroes of Athens, Georgia.* 1918. 30 p. 25 cents.

5. Long, Francis T. *Negroes in Clarke County, Georgia, During the Great War.* 1919. 56 p. 35 cents.

6. Reed, Ruth. *The Negro Women of Gainesville, Georgia.* 1921. 61 p. illus. 40 cents.

7. Scarbrough, Dorothy D. *An Economic Study of Negro Farmers as Owners, Tenants and Croppers.* 1924. 37 p. illus. 25 cents.

8. Patrick, James R. *A Study of Ideals, Intelligence and Achievements of Negroes and Whites.* 1926. 48 p. illus. diagrams. 40 cents.

9. Fanning, John W. *Negro Migration.* 1930. 39 p. diagr. maps. 40 cents.

10. Wilson, Ernest B. *The Water Supply of the Negro.* 1930. 80 p. Illus. 80 cents.